ANNEX 2

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ANNEX II

SUBJECT: TECHNIQUES IN THE LAYING AND CLEARING OF MINE FIELDS

1. PROBLEM. To study existing techniques in the laying and clearing of mine fields. This study should include all methods of laying and clearing mine fields both manually and by machine. The marking and recording of mine fields should be considered. The desirability and practicability of camouflage measures in the laying of mine fields should be carefully considered.

2. ASSUMPTIONS.

a. The doctrinal concept presented in Annex I is approved.

b. Mine laying devices to be available in the near future will not be capable of planting, arming, and covering mines in all types of terrain and will not represent a major savings in labor over present methods.

c. Immediate large-scale procurement of mine warfare material will necessarily be confined to mines of conventional types incorporating minor improvements only.

d. Mine detection and clearing devices and methods to be available in the near future will provide only marginal improvements over currently available materials and present methods.

e. Development items of mine warfare material may require revised or new techniques as they become available.

f. Sufficient training will be given all personnel to enable them to be cognizant of the approved doctrines and techniques.

g. Mine warfare training of the arm and services has been inadequate to enable them to properly understand existing techniques.

3. FACTS. Present doctrine and techniques are prescribed in Department of the Army FM 5-32, May 1949.

4. DISCUSSION.

a. To accomplish the mission stated in paragraph 1 above, four individual studies have been made. These studies are enclosed. They are:

Appendix A. Reconnaissance, Planning, and Characteristics of Mine Fields.

Appendix B. Mine Field Marking, Reporting, and Recording.

Appendix. C. Pattern and Densities of Mine Fields.

Appendix D. Mine Field Clearance

k Appendixes E & F are proposed changes to FM 5-32 Land Mine Warfare

5. CONCLUSIONS.

a. Presently prescribed techniques for reconnaissance and for planning installations of mine fields are incomplete.

b. Presently available mine warfare material provides sufficient variety of types of mines to permit reasonably effective installation of all the functional types of mine fields proposed by this panel.

c. True randomness in laying mines is impracticable.

d. The minimum acceptable density for antitank mine belts using pressure actuated mines laid to pattern is one antitank mine per yard of front.

e. Tactical requirements of functional fields as proposed by this panel will require judicious scattering of mines and laying mines to standard and nonstandard patterns.

f. Extensive route mining of major highways is extremely time consuming when utilizing existing equipment and/or explosives

g. Present doctrine requires detailed recording for some mine field for which such records are not necessary.

h. The recording of the location of individual antipersonnel and all activated mines is based on the accuracy of the measuring equipment. As this largely consists of the ability of the human eye to determine angles, records requiring accuracy to the foot over distances of 18 yards are not reliable.

i. The degree of detail required in records is based on future tactical plans, the composition of the field and the methods of placement.

j. Proper marking of mine fields reduces the recording requirements.

k. Present marking equipment is satisfactory for all requirements except assault gapping.

l. Present methods employed in reconnaissance for mine field breaching are incomplete.

m. Present methods employed in mine field breaching can be improved without the provision of new equipment.

n. Concealment of individual mines should be continued where practical. Where machine laying makes it impractical to camouflage the mine installation, areas not containing mines must be made suspect by marking similiar to that made by machine laying.

o. The specific purpose of an interdictory field, the type of mines and fuzes used and the methods of installation all have a bearing on density. No particular density can be prescribed as standard, however, individual spacing of antitank mines may vary from about 15 yards to sympathetic detonation range and in general, antipersonnel mines should protect each antitank mine.

6. RECOMMENDATIONS.

a. That revised techniques for reconnaissance and planning installations of mine fields as discussed in appendix A and delineated in appendix E be approved.

b. That a density of one antitank mine per yard of trace of a mine belt be adopted as the minimum essential requirement for fields laid to pattern.

c. That the pattern and drill discussed in appendixes C and E be adopted and standardized for use on those installations where standard patterns are required.

d. That the principles to be observed for nonstandard pattern and scattered mine laying discussed in appendixes C and E be approved.

e. That a method and/or equipment be developed to enable the rapid placement of large quantities of mines in major highways.

f. That the forms for mine field records discussed and illustrated in appendixes B and E be approved.

g. That methods of mine field breaching reconnaissance discussed in appendixes H and F be approved.

h. That the methods of mine field breaching discussed in appendixes D and F be approved.

i. That appendixes E and F be approved as the basis for revising chapters 3 and 5 of FM 5-32.

j. That as development equipment is adopted as standard agencies responsible for training literature publish information outlining the characteristics of that equipment and its effect on the approved mine warfare techniques.

k. That if the revised mine installation and clearance techniques recommended herein be adopted, that sufficient training time be allocated and training inspections conducted to insure that the revised techniques are fully assimilated by troops.

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APPENDIX A

RECONNAISSANCE, PLANNING, AND CHARACTERISTICS OF MINE FIELDS

1. PROBLEM. To evaluate presently approved doctrine and techniques for the reconnaissance, planning, and installation of various types of mine fields with the objective of developing the most effective integration of mine warfare with other weapons systems.

2. FACTS.

a. Present doctrine and techniques are prescribed in Department of the Army FM 5-23, May 1949.

b. Insufficient mine stocks of any type exist to permit large-scale utilization of mine warfare in the immediate future by this country and its probable allies.

3. ASSUMPTIONS.

a. Immediate large-scale procurement of mine warfare material would necessarily be confined to mines of conventional types, incorporating minor improvements only.

b. Mine laying devices to be available in the near future will provide only minor labor saving advantages over manual emplacement.

c. Mine detection and clearing devices and methods to be available in the near future will provide only marginal improvement over currently available material and methods.

d. Improved doctrine and techniques for the employment of conventional material will result in more effective mine warfare.

e. Development items of mine warfare material will progressively contribute to the effectiveness of mine warfare.

f. The concepts advocated by this panel of tactical employment of even conventional type material will result in more effective mine warfare.

4. DISCUSSION.

a. Reconnaissance. The present principles for reconnaissance for siting of mine fields recognize the necessity for prior map reconnaissance, proper utilization of supporting weapons, and coordination to provide proper fire support for the mine field and to avoid adverse effect upon future operations. The limitations of availability of mines, supporting troops, and weapons are also stated. Reconnaissance, according to these principles, has the advantage of insuring that the minefields so sited will receive maximum fire protection and have minimum effect upon later operations. The major disadvantages are that no consideration is given to the siting of mine fields not completely covered by fire, nor to provision of surveillance of mine fields not covered by fire, nor to the possibility of progressive improvement

or reinforcement of the mine field after initial installation. The primary disadvantage of the present siting of mine fields is the failure to emphasize the importance of integrating mine field planning with operational and fire support plans of all types, such as tactical air, etc. Reconnaissance for possible mine field sites should be continuous in the same manner as reconnaissance for possible field artillery positions is conducted. Reconnaissance of this type is particularly important when meeting engagements result in unanticipated retrograde movement.

b. Planning. Other than implied planning with respect to mine field siting, the present doctrine does not prescribe principles or technique for any mine warfare planning. Coordination with operational planning to insure the most effective mine warfare integration with counterattack; ground fire, tactical air, and chemical support; or other tactical plans is not provided. Planning of the use of various types of mine fields for different tactical purposes is not mentioned. No recognition of the effect of enemy capabilities upon planning is evident. For example, mine fields need not contain antitank mines against an enemy who has no tanks. No consideration is given to the establishment of priorities in mine warfare planning. There is no consideration of the establishment of a logistic requirement and logistic support plan to support the mine warfare planning. Finally, in addition to the failure to prescribe proper coordination, there is no recognition of the necessity of complete dissemination of approved mine warfare plans. Of course, the principles of planning should be adequately and practically covered in statements of technique.

c. Characteristics of mine fields.

(1) The characteristics of mine fields which are important to the determination of the proper techniques for installation of these fields include:

(a) The function the field is to fulfill.

(b) The composition or types of mines to be utilized.

(c) The densities and patterns to be observed in laying the field.

(d) The method of installation to be utilized, to include drills, if applicable.

(e) Provisions for later improvement or reinforcement of the mine field.

(f) The marking or recording necessary for the field.

(g) The resistance to breaching or difficulty of removal of the mine field.

(2) This substudy is concerned only with the composition, general methods of installation, provision for reinforcement or improvement, and considerations of breaching or clearance of mine fields as dictated by by the function the field is to perform.

(a) Composition of mine fields. The composition of a mine field, or the characteristics of the individual mines or combinations of different types of mines which make up the mine field, has an important effect on the tactical usefulness of the field. Small nonmetallic mines are difficult to remove and large metallic mines relatively easy to clear. Flares are of practically no value in unguarded fields, but provide warning and illumination for defending troops when these forces are present. Antipersonnel mines used alone or antitank mines used by themselves are both fairly simple to clear or breach, but are difficult to overcome when used in combination. Generally, mine fields difficult for friendly forces to clear present at least an equal difficulty for the enemy. The composition of mine fields must be determined in full coordination with operational plans.

(b) General methods of installation. General method of installation include manual, mechanical, or aerial installation. Specific methods in distinction to general classification, include the specific drills and procedures for manual installation; the specific types and characteristics of the various types of mechanical mine layers; and the specific characteristics of installation by air drop, rockets, artillery, or mortars.

(c) Provision for reinforcement or improvement. Initial planning must make provision for improvement or reinforcement of various type mine fields. The necessity for leaving access routes through fields to permit extension in depth toward the enemy must be considered. Access routes must be provided within the field to permit remining of belts to increase density, or to lay antipersonnel mines or warning devices which may have been omitted during initial installation. Enemy breaches must be similarly repaired. Additional belts may be laid between initial belts if adequate provision has been made for access and space.

(d) Breaching or clearance. The composition of a mine field, as dictated by the function the field is to fulfill, also determines the resistance of the field to either hostile or friendly breaching or clearance. In some types of fields, access routes contemplated for operational plans may require outright gaps or areas protected only by types of mines which are relatively easy to remove.

d. Security mine fields. These mine fields are used to provide local protection for small units.

(1) Composition. The composition of these fields should either be such as to provide warning and be effective against hostile vehicles and personnel but still be easy for friendly forces to remove, or be of limited armed life. Metallic antitank and antipersonnel mines and warning flares are the only currently available materiel suitable for use in these mine fields. Successful self-sterilization will permit the security use of mines inherently more difficult to remove during their armed life. Available materiel includes the M6, T27, and UK MK-VII antitank mines; the M2A4 antipersonnel mine; and the M49 trip flares.

(2) Method of installation. Since security mine fields are very limited in extent and installed by small units, these mine fields will be installed manually.

(3) Provision for reinforcement or improvement. Because these fields are limited to metallic mines, easily detectable by present mine detectors, only minimum gaps need be provided to permit mine-laying parties to move through the field to increase the depth of the field in the direction of the enemy. The use of [illegible] also permit relatively safe mine-laying operations within the field to increase density. Because security mines will normally be placed just outside of hand grenade range of friendly troop positions, there will be little occasion to increase depth in the direction of friendly forces. When security fields are to be incorporated in defensive mine fields, the first step should be protection of all metallic mines with nonmetallic antipersonnel mines, proofproof mines, if available.

(4) Breaching or clearance. Security mine fields are limited to easily detectable mines, either by probing or by use of currently standard detectors, consequently friendly removal is relatively easy, and enemy breaching can only be effectively countered by effective defensive fire cover for such mine fields.

c. Defensive mine fields. These mine fields are used to improve the obstacle plan in front, or on the flanks of a battalion, regimental, or division sector or zone.

(1) Composition. These mine fields are susceptible of more detailed planning and careful installation than security mine fields and will permit the use of nonmetallic antitank and antipersonnel mines in certain portions as well as metallic mines in those portions where later clearance may be anticipated. Breachproof mines and "beefed-up" tank-killing mines may also be used in relatively small quantities, for instance 2 percent of all antitank mines might be "beefed-up" to 50 pounds of high explosive, and 10 percent of the antitank mines might be of the breachproof variety. Anti-lift devices may also be utilized. Flares or other warning devices should be provided. Available material includes the M6, T27, and UK MK-VII antitank mines; the M2A4, M14 and UK "Stick" antipersonnel mines; and the M49 trip flare.

(2) Methods of installation. Defensive mine fields are normally installed manually to prescribed patterns and mechanically to fixed patterns. The use of antipersonnel mines is virtually unrestricted except in those portions where friendly breaching is anticipated. Under extreme conditions, aerial installation may be utilized for remining or reinforcement.

(3) Provision for reinforcement or improvement. Access routes should be provided for extension of the fields in depth either in the direction of hostile or friendly forces. Portions of the field not initially containing antipersonnel mines may be reinforced by installations of superimposed or adjacent belts of antipersonnel mines. Aerial installation of mines provides a means of rapid reinforcement of any portion or such fields.

(4) Breaching or clearance. Breaching or clearance of defensive mine fields is difficult if the necessity for such operations has not been anticipated at the time of initial installation. Areas of the field for which later friendly breaching operations are contemplated are most easily breached if the mines installed in these areas are restricted to metallic types. Of course, clear gaps may be provided if sufficient defending fire support is available to prevent hostile exploitation of such gaps. If the stronger portions of such fields must be breached, the best available system is a combination of explosive and mechanical methods. Detonation of linear explosive charges will clear effective widths of paths through antipersonnel mines and partially effective gaps through antitank mines. Use of the mine-clearing roller after the explosive method should result in complete clearance of adequate lanes. Manual removal of mines remaining after the use of explosive methods may also be effective. However, the possibility of unexploded mines becoming extremely sensitive after exposure to blast must be considered in manual-removal techniques.

f. Barrier mine fields. These mine fields are designed to be as nearly impenetrable as possible, even in the absence of covering fire, and should contain the same types of mines as defensive fields with higher concentrations of nonmetallic antipersonnel mines and breachproof antitank mines. Antilift and antidetection devices should be liberally employed. Warning devices should be liberally installed so that even limited surveillance may detect hostile attempts at breaching. Available material includes the M6, T27, and UK MK-VII antitank mines; the T6, M14, and UK "Stick" antipersonnel mines; and the M49 trip flare. The M83 butterfly bomb may be used to reinforce barrier mine fields. As can be seen from the function and composition of the barrier fields, virtually the same principles with respect to methods of installation, provision for reinforcement or improvement, and breaching or clearing apply to these mine fields as apply for defensive mine fields.

(5) Interdictory mine fields. These mine fields which are primarily designed to deny the use of areas to the enemy, even in the hostile rear, should contain the same types of mines as the most highly developed portions of the barrier fields, with the addition of booby traps and "dirty trick" devices, but with no requirement for warning devices. Available material includes the UK MK-VII antitank mine and the M14 and UK "Stick" mine. Improvised box mines should also be employed. Remining may be accomplished through use of the M83 butterfly bomb. These mine fields are very similar to defensive and barrier mine fields with respect to all applicable techniques of installation, reinforcement, and breaching.

g. Deceptive mine fields. These simulated mine fields should represent actual mine fields as closely as possible and utilize improvised simulated mines. A few live mines may be seeded throughout the field to insure that the enemy must make a complete clearing effort. Technique of installation should be simulated as well as locations of individual mines.

5. CONCLUSIONS.

a. That presently prescribed doctrine and techniques for reconnaissance and for planning of mine fields is incomplete.

b. That presently available mine-warfare material provides sufficient variety of types of mines to permit reasonably effective installation of all the functional types of mine fields proposed by this panel.

6. RECOMMENDATIONS. That the material contained in Appendix E be incorporated in the appropriate field manuals.

ANNEX II

SUBJECT: TECHNIQUES IN THE LAYING AND CLEARING OF MINE FIELDS

1. PROBLEM. To study existing techniques in the laying and clearing of mine fields. This study should include all methods of laying and clearing mine fields both manually and by machine. The marking and recording of mine fields should be considered. The desirability and practicability of camouflage measures in the laying of mine fields should be carefully considered.

2. ASSUMPTIONS.

a. The doctrinal concept presented in Annex I is approved.

b. Mine laying devices to be available in the near future will not be capable of planting, arming, and covering mines in all types of terrain and will not represent a major savings in labor over present methods.

c. Immediate large-scale procurement of mine warfare material will necessarily be confined to mines of conventional types incorporating minor improvements only.

d. Mine detection and clearing devices and methods to be available in the near future will provide only marginal improvements over currently available materials and present methods.

e. Development items of mine warfare material may require revised or new techniques as they become available.

f. Sufficient training will be given all personnel to enable them to be cognizant of the approved doctrines and techniques.

g. Mine warfare training of the arm and services has been inadequate to enable them to properly understand existing techniques.

3. FACTS. Present doctrine and techniques are prescribed in Department of the Army FM 5-32, May 1943.

4. DISCUSSION.

a. To accomplish the mission stated in paragraph 1 above, four individual studies have been made. These studies are enclosed. They are:

Appendix A. Reconnaissance, Planning, and Characteristics of Mine Fields.

Appendix B. Mine Field Marking, Reporting, and Recording.

Appendix C. Patterns and Densities of Mine Fields.

Appendix D. Mine Field Clearance

k. Appendixes B & F are proposed changes to FM 5-32 Land Mine Warfare

5. CONCLUSIONS.

a. Presently prescribed techniques for reconnaissance and for planning installations of mine fields are incomplete.

b. Presently available mine warfare material provides sufficient variety of types of mines to permit reasonably effective installation of all the functional types of mine fields proposed by this panel.

c. True randomness in laying mines is impracticable.

d. The minimum acceptable density for antitank mine belts using pressure actuated mines laid to pattern is one antitank mine per yard of front.

e. Tactical requirements of functional fields as proposed by this panel will require judicious scattering of mines and laying mines to standard and nonstandard patterns.

f. Extensive route mining of major highways is extremely time consuming when utilizing existing equipment and/or explosives

g. Present doctrine requires detailed recording for some mine field for which such records are not necessary.

h. The recording of the location of individual antipersonnel and all activated mines is based on the accuracy of the measuring equipment. As this largely consists of the ability of the human eye to determine angles, records requiring accuracy to the foot over distances of 10 yards are not reliable.

i. The degree of detail required in records is based on future tactical plans, the composition of the field and the methods of placement.

j. Proper marking of mine fields reduces the recording requirements.

k. Present marking equipment is satisfactory for all requirements except assault gapping.

l. Present methods employed in reconnaissance for mine field breaching, are incomplete.

m. Present methods employed in mine field breaching can be improved without the provision of new equipment.

g. Camouflage of individual mines should be continued where practical. Where machine laying makes it impractical to camouflage the mine installation, mines must be made suspect by marking similar to that made by machine laying.

h. The specific purpose of an interdictory field, the type of mines and fuzes used and the methods of installation all have a bearing on density. No particular density can be prescribed as standard, however, individual spacing of antitank mines may vary from about 15 yards to sympathetic detonation range and in general, antipersonnel mines should protect each antitank mine.

6. RECOMMENDATIONS.

a. That revised techniques for reconnaissance and planning installation of mine fields as discussed in Appendix A and delineated in Appendix E be approved.

b. That a density of one antitank mine per yard of trace of a mine belt be adopted as the minimum essential requirement for fields laid to pattern.

c. That the pattern and drill discussed in Appendixes C and E be adopted and standardized for use in those installations where standard patterns are required.

d. That the principles to be observed for nonstandard patterns and scattered mine laying discussed in Appendixes C and E be approved.

e. That a method and/or equipment be developed to enable the rapid placement of large quantities of mines in major highways.

f. That the forms for mine field records discussed and illustrated in Appendixes D and E be approved.

g. That methods of mine field breaching reconnaissance discussed in Appendixes D and F be approved.

h. That the methods of mine field breaching discussed in Appendixes D and F be approved.

i. That Appendixes E and F be approved as the basis for revising Chapters 3 and 5 of FM 5-32.

j. That as development equipment is adopted as standard agencies responsible for training literature publish information outlining the characteristics of that equipment and its effect on the approved mine warfare techniques

k. That if the revised mine installation and clearance techniques recommended herein be adopted, that sufficient training time be allocated and training inspections conducted to insure that the revised techniques are fully assimilated by troops.

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APPENDIX A

RECONNAISSANCE, PLANNING, AND CHARACTERISTICS OF MINE FIELDS

1. PROBLEM. To evaluate presently approved doctrine and techniques for the reconnaissance, planning, and installation of various types of mine fields with the objective of developing the most effective integration of mine warfare with other weapons systems.

2. FACTS.

a. Present doctrine and techniques are prescribed in Department of the Army FM 5-23, May 1949.

b. Insufficient mine stocks of any type exist to permit large-scale utilization of mine warfare in the immediate future by this country and its probable allies.

3. ASSUMPTIONS.

a. Immediate large-scale procurement of mine warfare material would necessarily be confined to mines of conventional types, incorporating minor improvements only.

b. Mine laying devices to be available in the near future will provide only minor labor saving advantages over manual emplacement.

c. Mine detection and clearing devices and methods to be available in the near future will provide only marginal improvement over currently available material and methods.

d. Improved doctrine and techniques for the employment of conventional material will result in more effective mine warfare.

e. Development items of mine warfare material will progressively contribute to the effectiveness of mine warfare.

f. The concepts advocated by this panel of tactical employment of even conventional type material will result in more effective mine warfare.

4. DISCUSSION.

a. Reconnaissance. The present principles for reconnaissance for siting of mine fields recognize the necessity for prior map reconnaissance, proper utilization of supporting weapons, and coordination to provide proper fire support for the mine field and to avoid adverse effect upon future operations. The limitations of availability of mines, supporting troops, and weapons are also stated. Reconnaissance, according to these principles, has the advantage of insuring that the mine fields so sited will receive maximum fire protection and have minimum effect upon later operations. The major disadvantages are that no consideration is given to the siting of mine fields not completely covered by fire, nor to provision of surveillance of mine fields not covered by fire, nor to the possibility of progressive improvement

or reinforcement of the mine field after initial installation. The primary disadvantage of the present siting of mine fields is the failure to emphasize the importance of integrating mine field planning with operational and fire support plans of all types, such as tactical air, etc. Reconnaissance for possible mine field sites should be continuous in the same manner as reconnaissance for possible field artillery positions is conducted. Reconnaissance of this type is particularly important when meeting engagements result in unanticipated retrograde movement.

b. Planning. Other than implied planning with respect to mine field siting, the present doctrine does not prescribe principles or technique for any mine warfare planning. Coordination with operational planning to insure the most effective mine warfare integration with counterattack; ground fire, tactical air, and chemical support; or other tactical plans is not provided. Planning of the use of various types of mine fields for different tactical purposes is not mentioned. No recognition of the effect of enemy capabilities upon planning is evident. For example, mine fields need not contain antitank mines against an enemy who has no tanks. No consideration is given to the establishment of priorities in mine warfare planning. There is no consideration of the establishment of a logistic requirement and logistic support plan to support the mine warfare planning. Finally, in addition to the failure to prescribe proper coordination, there is no recognition of the necessity of complete dissemination of approved mine warfare plans. Of course, the principles of planning should be adequately and practically covered in statements of technique.

c. Characteristics of mine fields.

(1) The characteristics of mine fields which are important to the determination of the proper techniques for installation of these fields include:

(a) The function the field is to fulfill.

(b) The composition or types of mines to be utilized.

(c) The densities and patterns to be observed in laying the field.

(d) The method of installation to be utilized, to include drills, if applicable.

(e) Provisions for later improvement or reinforcement of the mine field.

(f) The marking or recording necessary for the field.

(g) The resistance to breaching or difficulty of removal of the mine field.

(2) This subsetuly is concerned only with the composition, general methods of installation, provision for reinforcement or improvement, and considerations of breaching or clearance of mine fields as dictated by by the function the field is to perform.

(a) Composition of mine fields. The composition of a mine field, or the characteristics of the individual mines or combinations of different types of mines which make up the mine field, has an important effect on the tactical usefulness of the field. Small nonmetallic mines are difficult to remove and large metallic mines relatively easy to clear. Flares are of practically no value in unguarded fields, but provide warning and illumination for defending troops when those forces are present. Antipersonnel mines used alone or antitank mines used by themselves are both fairly simple to clear or breach, but are difficult to overcome when used in combination. Generally, mine fields difficult for friendly forces to clear present at least an equal difficulty for the enemy. The composition of mine fields must be determined in full coordination with operational plans.

(b) General methods of installation. General method of installation include manual, mechanical, or aerial installation. Specific methods in distinction to general classification, include the specific drills and procedures for manual installation; the specific types and characteristics of the various types of mechanical mine layers; and the specific characteristics of installation by air drop, rockets, artillery, or mortars.

(c) Provision for reinforcement or improvement. Initial planning must make provision for improvement or reinforcement of various type mine fields. The necessity for leaving access routes through fields to permit extension in depth toward the enemy must be considered. Access routes must be provided within the field to permit reming of belts to increase density, or to lay antipersonnel mines or warning devices which may have been omitted during initial installation. Enemy breaches must be similarly repaired. Additional belts may be laid between initial belts if adequate provision has been made for access and space.

(d) Breaching or clearance. The composition of a mine field, as dictated by the function the field is to fulfill, also determines the resistance of the field to either hostile or friendly breaching or clearance. In some types of fields, access routes contemplated for operational plans may require outright gaps or areas protected only by types of mines which are relatively easy to remove.

c. Security mine fields. These mine fields are used to provide local protection for small units.

(1) Composition. The composition of these fields should either be such as to provide warning and be effective against hostile vehicles and personnel but still be easy for friendly forces to remove, or be of limited armed life. Metallic antitank and antipersonnel mines and warning flares are the only currently available material suitable for use in these mine fields. Successful self-sterilization will permit the security use of mines inherently more difficult to remove during their armed life. Available material includes the M6, 727, and UK MK-VII antitank mines; the M2A4 antipersonnel mine; and the M49 trip flares.

(2) Method of installation. Since security mine fields are very limited in extent and installed by small units, these mine fields will be installed manually.

(3) Provision for reinforcement or improvement. Because these fields are limited to metallic mines, easily detectable by present mine detectors, only minimum gaps need be provided to permit mine-laying parties to move through the field to increase the depth of the field in the direction of the enemy. The use of detectors should also permit relatively safe mine-laying operations within the field to increase density. Because security mines will normally be placed just outside of hand grenade range of friendly troop positions, there will be little occasion to increase depth in the direction of friendly forces. When security fields are to be incorporated in defensive mine fields, the first step should be protection of all metallic mines with nonmetallic antipersonnel mines, preboproof mines, if available.

(4) Breaching or clearance. Security mine fields are limited to easily detectable mines, either by probing or by use of currently standard detectors, consequently friendly removal is relatively easy, and enemy breaching can only be effectively countered by effective defensive fire cover for such mine fields.

c. Defensive mine fields. These mine fields are used to improve the obstacle plan in front, or on the flanks of a battalion, regimental, or division sector or zone.

(1) Composition. These mine fields are susceptible of more detailed planning and careful installation than security mine fields and will permit the use of nonmetallic antitank and antipersonnel mines in certain portions as well as metallic mines in those portions where later clearance may be anticipated. Breachproof mines and "beefed-up" tank-killing mines may also be used in relatively small quantities, for instance 2 percent of all antitank mines might be "beefed-up" to 50 pounds of high explosive, and 10 percent of the antitank mines might be of the breachproof variety. Antilift devices may also be utilized. Flares or other warning devices should be provided. Available material includes the M6, T27, and UK MK-VII antitank mines; the M2A4, M14 and UK "Stick" antipers[illegible] mines; and the M49 trip flare.

(2) Methods of installation. Defensive mine fields are normally installed manually to prescribed patterns and mechanically to fixed patterns. The use of antipersonnel mines is virtually unrestricted except in those portions where friendly breaching is anticipated. Under extreme conditions, aerial installation may be utilized for remining or reinforcement.

(3) Provision for reinforcement or improvement. Access routes should be provided for extension of the fields in depth either in the direction of hostile or friendly forces. Portions of the field not initially containing antipersonnel mines may be reinforced by installations of superimposed or adjacent belts of antipersonnel mines. Aerial installation of mines provides a means of rapid reinforcement of any portion or such fields.

(4) Breaching or clearance. Breaching or clearance of defensive mine fields is difficult if the necessity for such operations has not been anticipated at the time of initial installation. Areas of the field for which later friendly breaching operations are contemplated are most easily breached if the mines installed in these areas are restricted to metallic types. Of course, clear gaps may be provided if sufficient defending fire support is available to prevent hostile exploitation of such gaps. If the stronger portions of such fields must be breached, the best available system is a combination of explosive and mechanical methods. Detonation of linear explosive charges will clear effective widths of paths through antipersonnel mines and partially effective gaps through antitank mines. Use of the mine-clearing roller after the explosive method should result in complete clearance of adequate lanes. Manual removal of mines remaining after the use of explosive methods may also be effective. However, the possibility of unexploded mines becoming extremely sensitive after exposure to blast must be considered in manual-removal techniques.

f. Barrier mine fields. These mine fields are designed to be as nearly impenetrable as possible, even in the absence of covering fire, and should contain the same types of mines as defensive fields with higher concentrations of nonmetallic antipersonnel mines and breachproof antitank mines. Antilift and antidetection devices should be liberally employed. Warning devices should be liberally installed so that even limited surveillance may detect hostile attempts at breaching. Available materiel includes the M6, T27, and UK MK-VII antitank mines; the T6, M14, and UK "Stick" antipersonnel mines; and the M49 trip flare. The M83 butterfly bomb may be used to reinforce barrier mine fields. As can be seen from the function and composition of the barrier fields, virtually the same principles with respect to methods of installation, provision for reinforcement or improvement, and breaching or clearing apply to these mine fields as apply for defensive mine fields.

(5) Interdictory mine fields. These mine fields which are primarily designed to deny the use of areas to the enemy, even in the hostile rear, should contain the same types of mines as the most highly developed portions of the barrier fields, with the addition of booby traps and "dirty trick" devices, but with no requirement for warning devices. Available materiel includes the UK MK-VII antitank mine and the M14 and UK "Stick" mine. Improvised box mines should also be employed. Remining may be accomplished through use of the M83 butterfly bomb. These mine fields are very similar to defensive and barrier mine fields with respect to all applicable techniques of installation, reinforcement, and breaching.

g. Deceptive mine fields. These simulated mine fields should represent actual mine fields as closely as possible and utilize improvised simulated mines. A few live mines may be seeded throughout the field to insure that the enemy must make a complete clearing effort. Technique of installation should be simulated as well as locations of individual mines.

5. CONCLUSIONS.

a. That presently prescribed doctrine and techniques for reconnaissance and for planning of mine fields is incomplete.

b. That presently available mine-warfare material provides sufficient variety of types of mines to permit reasonably effective installation of all the functional types of mine fields proposed by this panel.

6. RECOMMENDATIONS. That the material contained in Appendix E be incorporated in the appropriate field manuals.

APPENDIX B

MINE FIELD MARKING, REPORTING, AND RECORDING

1. MISSION. To study the methods of marking, reporting, and recording mine fields.

2. ASSUMPTION. The personnel installing, marking, reporting and recording mine fields are not always well-trained in this work. It is assumed that mine-warfare training will be intensified in all arms and services.

3. FACTS.

a. Objections to the present situation are as follows:

(1) Reports and records are not always made.

(2) Any time lag between the actual mine-field installation and the reporting and recording of it, may affect the plans of the tactical commander.

(3) Inaccurate reports and records are of little value.

(4) Required reports and records are too detailed.

(5) Records including those made by trained personnel, showing the location of individual mines have not been accurate because of the limitations of equipment now used.

b. Reasons for present poor situation of mine-field reports and records.

(1) Lack of mine training.

(2) Lack of mine discipline.

(3) Reports and records are not made at time of installation.

(4) The present requirements call for a more detailed report than is necessary in all situations.

c. There is little, if any, objection to the present method of marking mine fields.

4. DISCUSSIONS.

a. Mine-field marking.

(1) The requirements for marking different types of mine fields are discussed in Annex No. 1.

(2) The present technique of marking mine fields as outlined in FM 5-32 (1949) and Ch 1 17 July 50 & TC 24 3 Aug 51 is adequate. Some battle reports from Korea, and some individuals returning from Korea have discussed the use of marking materials, other than the standard pickets and barbed wire. The objection is not to the technique involved, but to the use of certain material. Inclosure 1 is a statement of recommendations made by units in the 11th Airborne Division. This division has many Korea returnees in it. Their objections to barbed wire and pickets are:

(a) too much trouble

(b) too expensive

(c) material not available when needed

They recommend using thin smooth No. 14 wire, raised 24 inches above the ground on wooden stakes or on trees and natural posts when available. Also to have triangular markers attached to the fence at 25-yard intervals on the friendly side, and none on the enemy side.

(3) The standard marking materials should be used when available. When these materials are not available, the method of marking should be standard as outlined in Army literature, using materials that are available. The necessity for recording and reporting can be minimized when the mine fields are well marked. Provisions for marking safe lanes must be provided as given in FM 5-32 and Ch 1 thereto.

(4) The maintenance of the marking fences is a responsibility of the unit occupying the area where the field is located.

(5) The present methods of marking mine-field lanes are adequate except that there are no suitable provisions for marking lanes during assault breaching operations. When the snake, roller, jet, or mine plow breaches a lane, the only method of marking the breach, is the currently used and inadequate standard method. This method of marking does not seem to be entirely suitable, because it requires exposure of personnel and excessive time.

(6) Army Field Forces Board No. 2 is working on Project No. 1308, which is a study of requirements for mine-field marking equipment. A portion of the study was the testing of more suitable and lighter equipment. This equipment would facilitate the marking of mine fields and lanes by infantry assault units. Initiation of a project for the development of a mechanical mine-field marking device has been made.

b. The use of records and reports.

(1) All headquarters will keep special situation maps on which is graphically entered all essential information concerning friendly and enemy mine fields. This information is used to inform commanders, unit staffs, and troops in the mined areas. It is important, therefore, that reports and records of new mine fields be forwarded immediately to the proper headquarters. The operations officer should be the custodian of these records. All headquarters will keep a record of the number of mines issued to each unit, for periodic comparison with the records of mines installed.

(2) The detailed mine-field record is used primarily to facilitate the planning of tactical operations, gapping for passage of our attacking troops, changing gaps for friendly patrols, transfer of responsibility for defense of the sector, and removal of the mines when required.

(3) Records are kept locally by the installing unit to facilitate transfer of responsibility.

c. Responsibility for records and reports

(1) The headquarters authorizing a mine field is responsible for the required records and reports and the forwarding of them to all interested headquarters.

(2) The personnel installing the mine field are responsible for recording and reporting the information required by their headquarters.

d. Information required in records and reports. The minimum necessary information will vary with the different interested headquarters. The commander authorizing the mine field decides the degree of detail of the mine field record on various types of fields. It seems undesirable to require a record that is not obtainable. The record required should furnish information that is obtainable, accurate, and timely. It is recognized that there will be situations when mine fields will have to be installed without the supervision of highly trained personnel. These fields might be in the form of road blocks, a few mines around a position, or small security mine fields. In any of these situations accurate records would be necessary but the requirements might be for less detail than for other types of installations. The effect of mine discipline and the need of intensive mine training in all units must be stressed by all commanders in order to keep timely and accurate mine-field records and reports. Taking into consideration the personnel available, and the type of mine field to be installed and recorded, certain basic factors are to be considered. These certain factors which determine the degree of recording are: existing policy of the senior commander; future plans of the

commander; type of installation; necessity of moving patrols through the installation; permanency of the installation. Based on the above factors, variations in the amount of detail might be indicated.

e. Proposed steps in recording and reporting a mine field:

(1) As soon as the officer in charge of installing a mine field has organized and started his work, he sends a report containing the following information to the next higher headquarters:

(a) Location and extent of field

(b) Estimated time of completion

(c) Type of mines to be installed

NOTE: This may be done by telephone, coded radio message, or messenger.

(2) The location report (Incl #2) and the mine lane report (Incl #4) contain the minimum information required for an area that has been mined. These reports are prepared under the supervision of the officer in charge of installing the field. They are made out while the field is being installed. Mine fields are numbered in sequence by each unit as they are installed; this number is entered under mine-field number. The report shows the general location of the field, topographic and auxiliary markers, number and type of mines installed, date and time installation completed, signature of the officer in charge, and a sketch of the mined area. Terms not common to all arms and services should be explained on the front or back of the form. This report is to be forwarded to the next higher headquarters which is then responsible for distribution of the pertinent information to all units concerned.

(3) Should the commander require a more detailed report and record of the mine field the next step would be to prepare a record of mine-belt sections (Incl #3). This is the second degree of detail in mine-field reports and requires more thoroughly trained personnel. Here again need for intensive training is stressed. In this record a description of the mine field is given and it includes the number of belts, pattern, the use of scattered mines if any, and the azimuth and distance in yards for each belt. A sketch would show the accurate location of the topographical and auxiliary markers, sections of each belt, the magnetic north, and the direction of the enemy. All data on the sections of the mine belt would be entered on the form; if an item does not apply, it is so indicated on the report. This form is signed by the officer in charge. The belts are numbered starting from the friendly side, and the sections are lettered from right to left. The tabulated data will also show the azimuth, length, and depth of each section in each belt. The number of antitank mines, activated antitank mines, antipersonnel mines, and activated antipersonnel mines in each section is shown. When this practice is authorized, provision is made to show any mines scattered between belts, the number of

mines in each section by type, the total number of antitank mines, antipersonnel mines, and the combined total of mines in the field.

(4) When requirements exist for recording lanes in the mine field, the form to use is the detailed report of mine-field lanes. (Incl #4). This report locates a topographic marker by description, and coordinates; azimuth and distance to the entrance of each lane; azimuth, length, and width of each lane and how marked. The provisions for closing the lanes are entered. A sketch will show the location of the topographic marker or markers and the lanes. This report will be signed by the officer in charge.

(5) Normally recording of individual antipersonnel and antitank mines will not be made. In specific situations a commander may require the location of individual antipersonnel and activated mines in portions of the mine field. This report will require one sheet for each section of the mine field. This record (Incl 5) shows the section designation and a sketch of that section showing the antipersonnel mines and the activated mines by number. In the tabulated data, each numbered mine is listed showing type of antipersonnel or activated mine, type of fuse, distance from right section stake, and distance from row 1. All distances on this report are given in feet. This report is signed by the officer in charge.

(6) Any alteration to a mine field, changing of lanes, removal of mines, or clearing of a field will be reported by the unit making the change. As changes are made, or mines are removed, a complete report marked revision is submitted. This report is then forwarded to the next higher headquarters. This headquarters is responsible for distribution of the information to all units concerned.

f. Types of Mine Fields

(1) Security mine fields.

(a) This mine field may consist of a few mines or several groups of mines. These fields are marked by wire surrounding the field, with triangular mine markers on only the friendly side.

(b) As soon as the work is started the Preliminary report must be sent to the next higher headquarters. After the installation is completed, the Location report is forwarded to this headquarters. The commander installing the field must make a careful notation of each mine installation and the type of firing devices used. Also he must be sure that several alternates are aware of this information. These notations cannot be made suitably on the detailed mine-field report. The notations do not go forward with the location report, but are kept by the unit with a copy of the location report, to facilitate making any necessary changes in the mine field, removing the mines, or in the transfer of responsibility

(c) When the location of the field or the number of mines is changed a revised location report is submitted.

(d) Each echelon receiving these reports must consolidate them and forward them through channels to the Division.

(2) Defensive mine fields

(a) A defensive mine field may consist of one or more mine belts. These mine fields may be installed in rear positions to add depth to the battle positions. At the time of installation the field must be marked with wire and the standard mine-field markers placed on the wire. The fencing and markers surround the field. Marking fences and signs on the enemy side of the mine field may be removed after security forces have been withdrawn.

(b) The degree of detail required in the mine-field report must be a decision of the commander authorizing the field. Before it is installed the Preliminary report must be sent to the next higher headquarters. Next, the Location report is completed and forwarded to the next higher headquarters, simultaneously with the completion of the mine field. When the commander requires a more detailed record of the mine field, the detailed records will be made on the following forms: Detailed record of mine belts, Detailed record of mine lanes, Detailed Record of each mine Section: These records are not designed for amphibious installations but may be modified for this purpose. The commander installing the mine field is responsible for marking and recording.

(c) Copies of the records and reports are forwarded to the next higher headquarters. That headquarters consolidates reports for its units and forwards them to higher headquarters up to and including Army.

(3) Barrier Mine Fields

(a) The barrier mine field may consist of numerous belts, and areas containing scattered mines. This requires a large overall plan and numerous units to install it. These mine belts may be installed in advance of contact with the enemy and may be to the rear of friendly troops.

(b) Each belt or group of belts of the barrier mine field and each safe lane through it will be marked with wire and the standard triangular markers. Marking fences and signs forward of the mine field may be removed after the security forces have withdrawn.

(c) As the barrier mine field will consist of numerous installations by numerous units, there will be many reports and records. Each unit [redacted] an installation must make the Preliminary report and the Location report for their installations. A detailed report is not

practical when scattered mines are installed. There will be some patterned installations, however, where a detailed report will be possible, and required by the commander. In any event detailed records will be prepared when the commander directs. The commander of the installing unit is responsible for proper recording and reporting.

(d) The records and reports when prepared must be forwarded to the next higher headquarters. This headquarters must consolidate the records and reports and forward them through channels to the commander authorizing the installations.

(4) Deceptive Mine Fields

(a) The deceptive mine field may or may not contain live mines.

(b) To be effective as a deceptive mine field, all sides of the field must be marked with wire, and with the triangular markers attached as on a regular mine field. The effect here is to have the enemy believe that he has encountered a real mine field. The markers will assist in this deception.

(c) The Preliminary report and the Location report will be made for this installation. The commander authorizing the installation decides the need for a more detailed report of this deceptive field, if some live mines are used. The commander of the unit installing the field is responsible for making the reports and records required.

(d) The records and reports when prepared must be forwarded to the next higher headquarters. This headquarters then consolidates and forwards the records and reports through channels to the commander authorizing the installation.

(5) Interdictory Mine Fields.

(a) The interdictory mine field may contain all types of mines, "dirty trick" devices, and booby traps. The mines may or may not follow a pattern. Security, defensive, barrier, and deceptive mine fields are considered interdictory mine fields after they have fallen into enemy hands.

(b) The marking of an interdictory mine field is not required unless the lack of it will endanger the safety of our own troops before it falls into enemy hands. The commander ordering the installation of the field will specify the extent of the marking to be used. Any markings may be removed after withdrawal of the security forces.

(c) The commander ordering the installation of an interdictory mine field will decide the need for a detailed report. The

Preliminary report and the Location Report will be made for all interdictory mine fields installed. The commander of the unit installing the mine field is responsible for preparing the required reports. These reports and records will be forwarded to the next higher headquarters.

(d) The headquarters receiving these reports and records will consolidate and forward them to the commander ordering the installation.

5. CONCLUSIONS.

a. Marking.

(1) The present method of mine field marking is adequate.

(2) The only changes in standard marking procedures should be those changes prescribed by international standardization agreements.

b. Records and reports.

(1). The present method of records and reports of a mine field requires more detailed information than is necessary in every situation.

(2) The minimum necessary mine-field records have not been available to interested headquarters in the past because of:

(a) Inadequate mine training.

(b) Inadequate mine discipline.

(c) Limitations of personnel and equipment.

(3) Advantages of the proposed records.

(a) Provide a form for the minimum essential information on a mine field (Incl 2).

(b) Provide progressively detailed forms when the requirements exist for this information (Incls. 3, 4, and 5). Using these methods of recording, reports of mine-field locations will be more prompt, unnecessary detail may be eliminated, and detail not possible to attain with accuracy normally will not be required.

(c) Intensive training in mine discipline and mine warfare must be stressed by all commanders.

6. RECOMMENDATIONS.

a. That the proposed forms for reporting and recording be adopted, and the proper changes made in pertinent manuals.

b. That Commanders at all levels stress mine training at all times.

Inclosure 1

Recommended Modification in FM 5-20 By Units of The 11th Airborne Division

1. Markings.

a. Barbed wire and pickets

(1) Too much trouble

(2) Too expensive

(3) Material not available when needed

b. It is recommended that a No. 14, smooth wire - raised 24 inch s off the ground with wooden stakes, making use of trees and natural posts when available, be used. Triangular markers employed at 25-yard intervals on the friendly side; none on the enemy side.

••••••••••••

6. Recording.

Recording data as currently recommended and attempted is too accurate for practical usage. It is too difficult to carry out during extreme cold weather and at night. It is necessary that the topo marker, to locate the right rear reference stake, be accurate and then give only an outline of the area with the number and types of mines and antipersonnel mines used. It is also necessary to clear fields in an identical manner with detector teams whether they are recorded and in pattern form or not. Usually there is no hurry to clear fields, but emphasis should be placed on completing the wire around the field even to the extent of making use of available signal wire, strung twenty-four inches off the ground and employing minefield markers on the friendly side.

Inclosure 2

LOCATION REPORT OF MINE FIELD

1. Unit laying:

   a. Mine Field No: b. Sheet _____ of _____ sheets

2. Authority:

3. Map reference:

4. Topographic Marker:

   Description: Description:

   Coordinates: Coordinates:

   Distance and az to danger area: (See Sketch) Distance and az to danger area:

5. Auxiliary or marker: Description: Distance and az to danger area:

6. Approximate dimensions of field; see sketch.

7. Boundary marking of field, describe.

8. Total number of mines installed: Antitank _____ Antipersonnel _____

9. Date and time installation completed:

10. Signature of officer in charge:

(Sketch to include: topo marker; aux marker; dimension of field; general location of boundary marking; magnetic north; and direction of the enemy). Topographical markers: - A terrain feature that is easily identified on the ground and on a map.

Auxiliary marker: - An artificial marker placed on the ground.

Inclosure 3

DETAILED RECORD OF MINE BELT(S)

1. Unit

   a. Mine field No. b. Sheet ____ of ____ sheets.

2. Description of mine fields to include: number of belts, pattern, use of scattered mines.

3. See sketch for location of topographic and auxiliary markers.

4. Data.

Sec	Ad	Length Yds	Depth Yds	Anti Tank Mines				Anti Personnel Mines				Total In Section
				Total		Activated		Total		Activated		
				No.	Type	No.	Type	No.	Type	No.	Type	
Between Belts												
			Total									
			Total Anti Tank			Total Anti Personnel				Total in Field		

5. Signature of officer in charge

6. Date.

Inclosure 4

DETAILED RECORD OF MINE-FIELD LANES

1. Unit

a. Mine field No. b. Sheet _____ of _____ sheets.

2. Date:

Lane No.	Topographic Marker		Lane				
	Description	Coordinates	As to Lane Entr.	Dist. to Lane Entr.	As	Length	Width	How Marked

3. Provisions for closing the lanes:

4. (Sketch on back showing lanes.)

5. Signature of officer in charge: _____

6. Date: _____

Inclosure 5

DETAILED RECORD OF EACH MINE SECTION

ANTIPERSONNEL AND ACTIVATED ANTITANK MINES

1. Unit

   a. Mine field No. _____. b. Sheet ____ of ____sheets

2. Section:

3. To accompany sheet:

4. Sketch:

5. Data:

Mine No.	Type of Antiperso. Mine	Type of Activated Antitank Mine	Type of Fuse	Distance From Right Section Stake	Distance Forward of Row 1

6. Signature of officer in charge: _____

7. Date: _____

APPENDIX C

PATTERNS AND DENSITIES

1. PROBLEM. To furnish military personnel a practical technique for placing mines in groups so as to extract the maximum loss and/or reduction of the enemy's offensive capabilities.

2. ASSUMPTIONS.

a. That doctrine recommended by this study and as outlined in Annex 1 is accepted.

3. FACTS. Present techniques are presented in FM 5-32, May 1949.

4. DISCUSSION.

a. Patterns and nonpattern laying.

(1) Random laying. True random laying of mines in an area is not possible. When mines are laid by individuals, several factors tend to prevent true randomness. Some of these factors are as follows:

(a) The individual will usually place the mine where he thinks it will be most effective.

(b) The individual must carry the mines from a dump into the field. It is not probable that he will carry the same percentage of mines to the extreme limits of the area as he would to areas close to the dump.

(c) The individual will be affected by the terrain, tending to take the easier routes into the area.

(2) Pattern and Scattered laying. Although true randomness cannot be achieved, it is possible to lay mines without a definite geometric pattern. Scattered laying is defined as the placement of individual mines without regard to the location of any other individual mine. The only exception is that one mine would not be laid within the sympathetic detonation range of another. The advantages of scattered laying are as follows:

(a) It makes the individual mine more difficult to locate. This in turn has resultant advantages. The enemy must utilize more time to breach or clear the field. As greater effort or time is placed on locating individual mines a higher return is received for the effort expended in installing the field.

(b) It prevents the enemy, through experience, from profitably analyzing our techniques in order to decrease the delay imposed upon him.

(c) The advantages of pattern laying as given in paragraph 20a, FM 5-32 are the following:

1. For speed and efficiency of installation.

2. To insure thorough coverage and proper density without excessive expenditure of mines.

3. To expose the minimum number of personnel at one time.

4. To make recording of the field easier.

5. To facilitate easy location and clearing.

(d) The last three advantages stated above can be minimized by the following arguments:

1. Proper organization for scattered laying would not expose any more personnel than do the present methods.

2. There is extreme doubt as to whether detailed recording of individual mines is necessary. This is discussed in other portions of the study. In any event, location of the mine field would not be more difficult to record.

3. Easy location and clearing is as advantageous to the enemy as it is to us. Perhaps it is more to his advantage for it is difficult to measure tactical success against post-combat effort.

(e) In order to make a comparison of the speeds and coverage of scattered laying and pattern laying, six tests were run by the Technical Committee. These tests and their results are attached as inclosure 1. It may be concluded that laying without pattern requires more time than laying to a pattern and that coverage is more uniform and certain when laying to a pattern. Scattered laying was difficult to attain, as noncommissioned and commissioned officers were prone to organize their work for efficiency and, as a result, tended to develop a pattern during the operation. It was apparent that the enemy would have a more difficult time clearing a field laid without pattern.

(3) Summary. There are advantages and disadvantages to both methods. The best advantages of both systems should be combined in a method suitable for drill laying and adaptable to varying the distances in depth of the installation. This method would give a variable pattern, maintain control of coverage, and provide for an efficient operation. Doctrine will specify when mines are to be laid to standard patterns, when scattered mines may be used, and when locally improvised patterns may be used.

b. Mine field density. The density of a mine field is defined as the average number of mines per linear unit of length. Density has been generally accepted as the most important measure of effectiveness of mine fields. The concept of mine field density has never been limited by considerations of depth of field, nor of arrangements of mines within the field. Actually, both depth of field and arrangements of mines within the field are independently, of important theoretical as well as practical effect in determining mine field effectiveness. These effects are obvious upon logical examination and are susceptible of simple mathematical proof. The more important practical effects of arrangement of mines within a field have been previously discussed. These effects include those of the sympathetic detonation range of individual mines and ease of hostile breaching of the field. This particular discussion is primarily concerned with theoretical considerations. Three cases are believed representative of the range of conditions normally encountered in mine fields; first, mines evenly spaced along a single row; secondly, mines evenly spaced along multiple rows; and lastly, mines distributed truly at random, or in such a manner that they may be considered to be individually and collectively positioned at random. For each of these three cases the effective firing width of an individual mine, the vulnerable width of the target vehicle and the density of the mine field will be assumed constant.

(1) Single row field. It is obvious that if mines are so closely spaced along a single row that the target vehicle cannot avoid encountering at least one mine in attempted passage, then mine initiation is certain and no probability analysis is required. However, to permit comparison among the three cases of mine arrangement the following mathematical interpretation is made:

Let P_i = probability of initiation of a mine by one vehicle.

f = vulnerable width of the target vehicle in yards. Variations of mine and/or vehicle characteristics may be considered in this value.

d = density of the mine field in terms of mines per linear yard of mine field.

Then, the probability of the initiation of a mine by a single vehicle in a single row field is $P_i = fd$ (1) and is a certainty for values of $fd = 1$. Practically, a single linear row of mines is tactically worthless because of simultaneous sympathetic detonation of all other mines in the row upon actuation by a target of any mine, and also, because of extreme ease of hostile breaching operations.

(2) Multiple row field or belt. The closest physical spacing of mines in a mine field which is possible within the limitations of sympathetic detonation range is that wherein mines within any individual row are spaced evenly at sympathetic detonation range and successive rows are offset or displaced laterally one half mine interval from adjacent rows, so that sympathetic detonation range is just exceeded between mines in adjacent rows. This arrangement is impractical because it would violate uniform density. The individual offsets of all the rows in a mine field must result in an approximately even spacing of individual mines when the locations of such mines are projected upon the linear trace of the field. The nearest practical approach to the extreme effectiveness of the single row field as regards attempted passage by a single vehicle is, therefore, the field in which proper offsets are observed with spacing between rows such that sympathetic detonation range is not violated. When these conditions obtain, and even though spacings of individual mine rows be indefinitely extended, the probability of initiation of a mine in the first mine row encountered by a single vehicle is $P_{i_1} = \frac{fd}{n}$ (2), where notation is as in the preceding subparagraph and n, the number of rows in the mine field. Probability subscripts indicate the row to which the probability applies. In determining probability of initiation of a mine in the second row it is assumed either that the approach is approximately normal to the row, or that the distance between adjacent rows is so great with respect to terrain, vehicle driving characteristics, and mine laying inaccuracies that the direction of approach to each mine row is an independent event. The necessity for accepting one or the other of these assumptions is necessary because when mine rows are offset from adjacent rows the practical possibility arises of the vehicle straddling pressure type mines or passing between influence type mines in all rows. However, either of these assumptions is considered reasonable and wholly acceptable since conscious effort will be made to site mine fields so that hostile approach will be generally perpendicular to the field, and even if approaches are not perpendicular to the field, three factors tend to increase probability of mine row effectiveness. First, practically all mine row offsets established by pacing are apt to vary rather than be strictly geometrical; secondly, the effective density of each individual mine row increases as the angle of approach deviates from the perpendicular; and finally, the approach in such a direction as to encounter greatly increased mine field effectiveness is equally likely as the "straddle" approach. Therefore, the probability of initiation of a mine in the second row may be accepted as:

$$P_{i_2} = (1 - f\,\frac{d}{a})\,(f\,\frac{d}{n}) \qquad (3)$$

and in the last row:

$$P_{i_n} = (1 - f\,\frac{d}{n})^{n-1}\,(f\,\frac{d}{n}) \qquad (4)$$

and probability of initiation in the field as a whole is:

$$P_i = P_{i_1} \neq P_{i_2} \neq \cdots P_{i_n} \qquad (5)$$

(3) Random mine fields. When the arrangement of mines within a mine field is such that the mines may be considered as being distributed individually and collectively at random, the Poisson Law of probability applies. This law applies to determination of probability when the number of trials is large and the probability of the occurrence of the event for any one trial is extremely small, conditions which certainly obtain when a vehicle encounters a truly random mine field. Practically, such distribution would require very deep mine fields in order that target vehicle approach to any individual mine could be considered as an independent event. The impracticability of laying mines randomly in the field has been discussed in par 4a, however pattern mine fields do not vary materially from those randomly placed. Aerially emplaced mines may approach such arrangements. Using previous notation and introducing: M = total number of mines; W = width of field; k is the number of mine initiations; and e = natural Logarithm base; the probability of the initiation of a single mine in a truly random mine field may be determined as follows: The Poisson Law expressed in previous notation for the occurrence of k mine initiations within a random field is:

$$P_{(k,1)} = \frac{(\frac{M}{W} f)^k}{k!} e^{-\frac{M}{W} f} \qquad (6)$$

Expressed for no mine initiations,

$$P_{(o,1)} = \frac{(\frac{M}{W} f)^o}{o!} e^{-\frac{M}{W} f} = e^{-\frac{Mf}{W}} \qquad (7)$$

Then

$$P_1 = 1 - e^{-\frac{M}{W} f} = 1 - e^{-df} \quad \text{since } d = \frac{M}{W} \qquad (8)$$

(4) Illustrative problems.

(a) Optimum density four-row mine field. What is the probability of initiation of a single pressure type mine by a JS III tank in a single passage of a four-row field laid at a density of 1 mine per yard of front?

f = 1.39 yards

d = 1 mine per yard of front

n = 4 rows of mines

$$P_{1_1} = \frac{1.39 \times 1}{4} = .35$$

$$P_{1_2} = (1 - \frac{1.39 \times 1}{4}) \frac{1.39 \times 1}{4} = .23$$

$$P_{i_3} = (1 - \frac{1.39 \times 1}{4})^2 \quad \frac{1.39 \times 1}{4} = .15$$

$$P_{i_4} = (1 - \frac{1.39 \times 1}{4})^3 \quad \frac{1.39 \times 1}{4} = .09$$

$$P_1 = P_{i_1} + P_{i_2} + P_{i_3} + P_{i_4} = .35 + .23 + .15 + .09 = .82$$

(b) Optimum density random mine field. What is the probability of initiation of a single pressure type mine by a JS III tank in a single passage of a random mine field laid to a density of 1 mine per yard of front?

d = 1 mine per yard of front

f = 1.39 yards

$$P_1 = 1 - e^{-df} = 1 - \frac{1}{e^{1.39 \times 1}} = 1 - .249 = .75$$

(c) High density six-row mine field. What is the probability of initiation of a single pressure type mine by a JS III tank in a single passage of a six-row mine field laid at a density of 3 mines per yard of front?

f = 1.39 yards

d = 3 mines per yard of front

n = 6 rows of mines

$$P_{i_1} = \frac{1.39 \times 3}{6} = .695$$

$$P_{i_2} = (1 - .695) \times .695 = .212$$

$$P_{i_3} = (1 - .695)^2 \times .695 = .065$$

$$P_{i_4} = (1 - .695)^3 \times .695 = .019$$

$$P_{i_5} = (1 - .695)^4 \times .695 = .006$$

$$P_{i_6} = (1 - .695)^5 \times .695 = .002$$

$$P_1 = P_{i_1} + P_{i_2} + P_{i_3} + P_{i_4} + P_{i_5} + P_{i_6} = .999$$

(4) High density random mine field. What is the probability of initiation of a single pressure type mine by JS III tank in a single passage of a random mine field laid to a density of 3 mines per yard of front?

$d = 3$ mines per yard of front

$f = 1.39$ yards

$P_1 = 1 - e^{-df} = 1 - e^{-4.17} = 1 - .015 = .985$

(5) Discussion. The above computations show that, for practical purposes, the difference in probability of mine initiation between a mine belt laid at random and one laid in rows, both having the same density, is of no great importance, being, only slightly higher for the field laid in rows. Therefore, the theoretical gain of initiation probability which results from pattern laying is of minor importance, Fig. 1. The probability of a kill is the probability of killing the tank in the event of a mine initiation for mines which are not capable of making a kill for every initiation. This consideration is of no importance for mines now available for issue, unless they are used in multiple or with explosive increments. It remains to estimate the optimum density for mine fields laid with present mines. This optimum density is that density for which an increase in density will not give an appreciable increase in P_1. The density is plotted in Fig 2 as abcissa against the function $P = 1 - e^{-fd}$ for values of f based on the JS III tank. Comparative curves for the JS III, the T34/85 and M46 tanks are shown in Fig. 3.

A comparison of the differences from Fig. 2 follows:

Table I

Increase in d

From	To	ΔP
0.0	0.5	0.50
0.5	1.0	0.25
1.0	1.5	0.13
1.5	2.0	0.06
2.0	2.5	0.03
2.5	3.0	0.02

For JS III Tank

It is seen in Fig. 2 that for a density of 1, $P_1 = 0.75$ and an increase in density of one half mine per yard of front will produce an increase in probability of mine initiation of only 0.13, Table I. This 50% increase in logistical requirements for mines is not justified by the small increase in probability of mine initiation realized. For mechanical laying, or paced spacing in rows, a mine belt of more than four rows of M-6 or equivalent mines will produce a probability of mine initiation of at least 75% against the JS III when the density is 1 mine per yard of front. More refined

methods of analysis are not justified because the densities will vary from the above practice due to the decisions made in the field by the officers in charge of the work. The decisions as to the number of belts in the field will vary the density of the field by increments of 1 mine per yard of front. The consideration of the effect of a field commander's decision to add even one additional belt further supports the selection of a normal density of 1 mine per yard of front. Addition of an additional belt to a belt of density of 1 will provide an increase in probability of mine initiation of .19 whereas if the original belt has a density of 1.5 the increase in probability would amount to only .10, and the overall advantage of the doubled more dense belts would amount to only .05, an extremely small return to receive for approximately half again the effort when measured in terms of numbers of mines and the physical work of installation.

c. Patterns for pressure actuated mines.

(1) The present six-row pattern gives a density of 1½ mines per yard of trace of mine belt. The lateral spacing of mines is somewhat irregular due to the method of measuring the distance between mines by pacing. The depth is fixed at 30 yards ± or - a few inches per belt. There has always been an objection to this fixed depth. The statement that a multiple belt will hamper an enemy in discovering the field's depth is not completely valid. It is common practice to lay one belt across the entire front. Then if mines and manpower permit, the field would be "thickened up" at the most critical points. This "thickening-up" process, having a lower priority, does not receive as much attention in operation as it does in theory.

(2) There is always one reason for retaining an existing pattern and drill. The troops are already trained and any change requires using additional hours of their time. In order to lay the six-row pattern with a 30-pound mine, a new drill will be required. The present drill prescribes that a man carry 3 mines totalling 60 pounds. It would not be practical to carry 3 30-pound mines.

(3) As the drill will probably change for the heavier mines, there is less objection to discarding the six-row pattern. The major portion of instruction is not devoted to the pattern but to the drill for laying it. If a new drill must be taught, it could be applied to a new pattern provided there are valid reasons for designing a new pattern.

(4) There does appear to be two reasons. They are:

(a) The conclusion that the minimum acceptable density is one mine per yard of trace of a mine belt.

(b) The need for variation in depth and/or mine spacing to achieve some of the advantages of nonpattern laying.

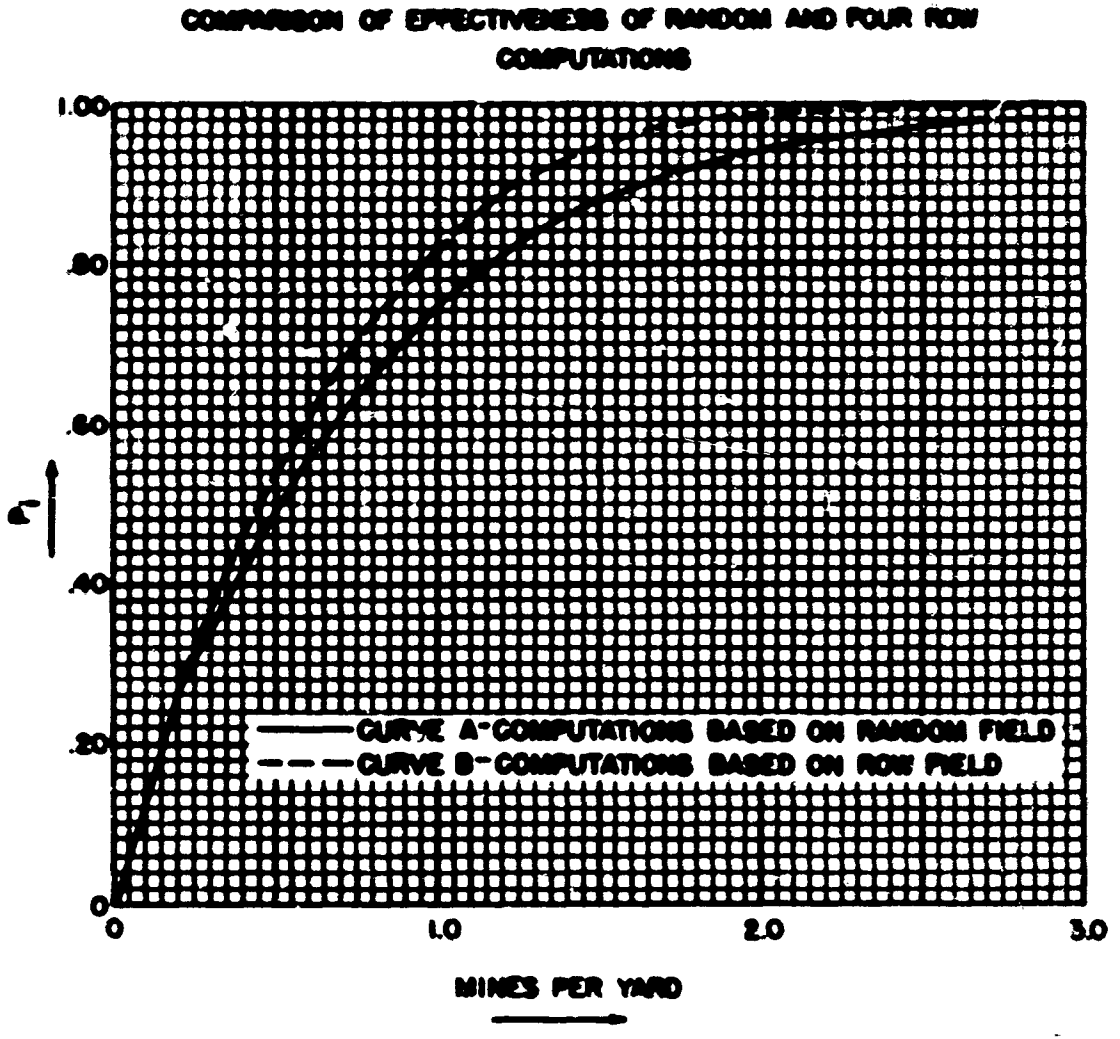

COMPARISON OF EFFECTIVENESS OF RANDOM AND FOUR ROW COMPUTATIONS
1.00
.80
.60
.40
.20
0
0
1.0
2.0
3.0
CURVE A-COMPUTATIONS BASED ON RANDOM FIELD
CURVE B-COMPUTATIONS BASED ON ROW FIELD
MINES PER YARD

Figure 1.

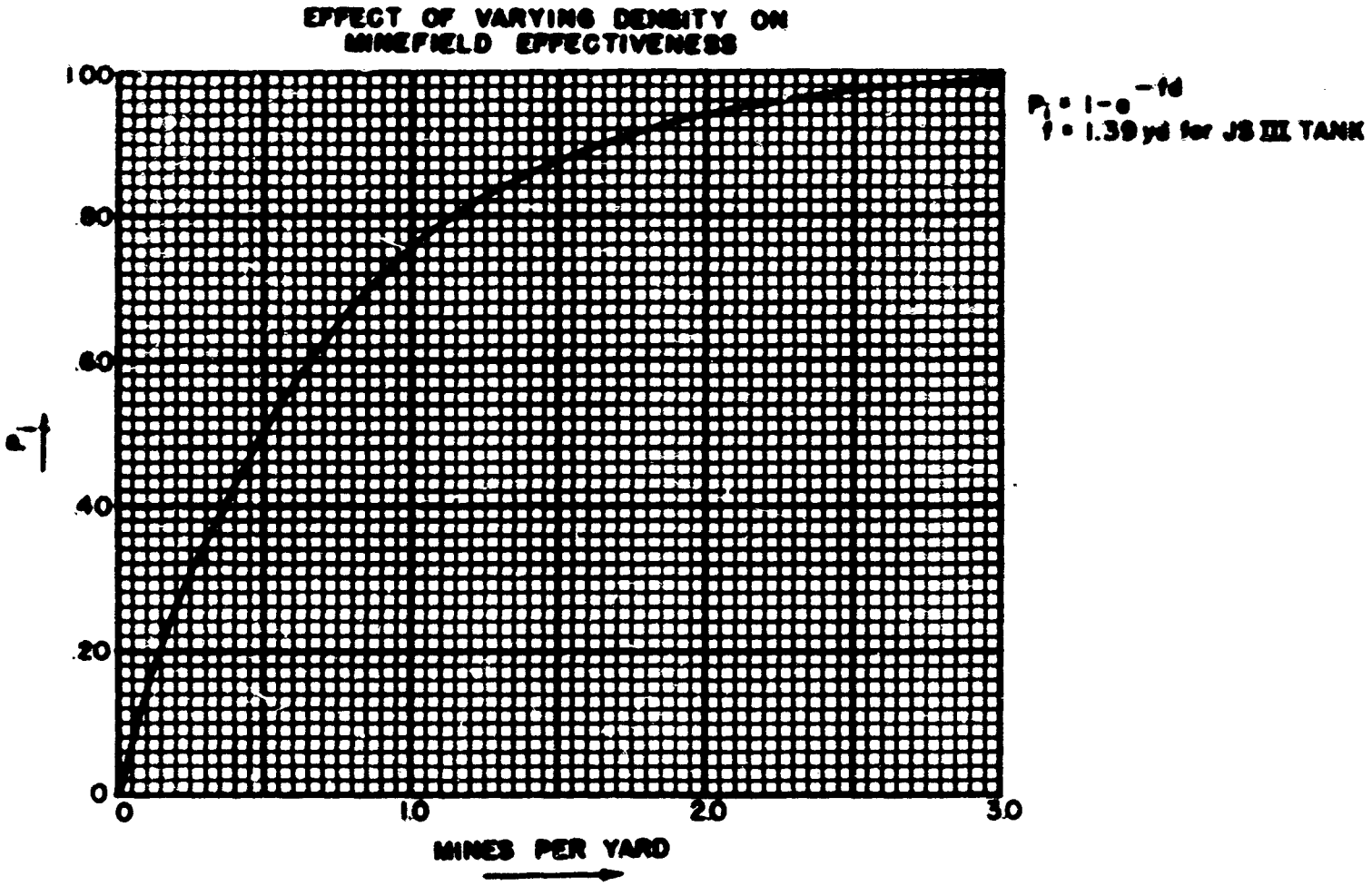

EFFECT OF VARYING DENSITY ON
MINEFIELD EFFECTIVENESS
100
80
60
40
20
0
0
1.0
2.0
3.0
MINES PER YARD
$P_1 = 1 - e^{-fd}$
f = 1.39 yd for JS III TANK

Figure 2.

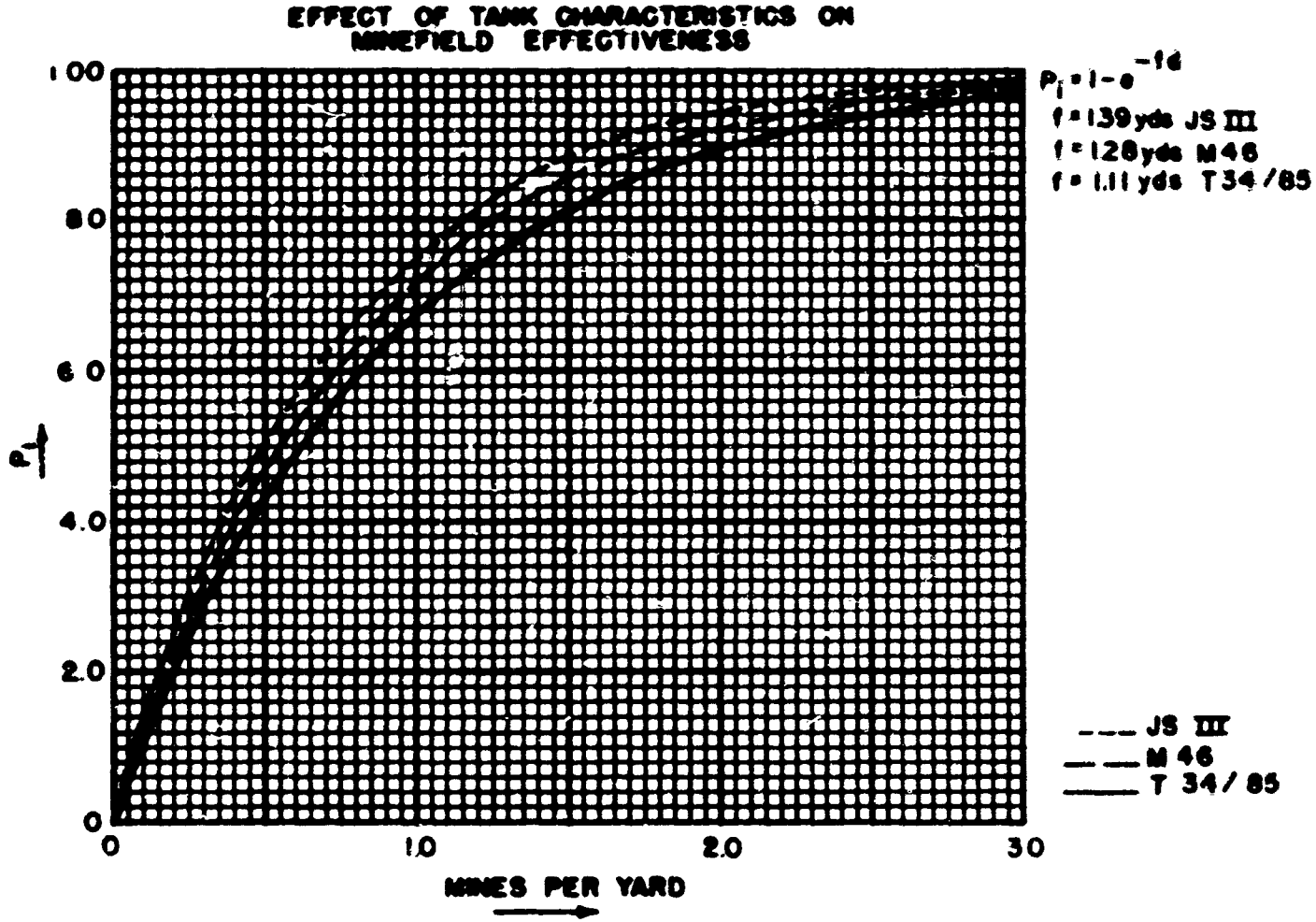

EFFECT OF TANK CHARACTERISTICS ON
MINEFIELD EFFECTIVENESS
1.00
8.0
6.0
4.0
2.0
0
P_i
0
1.0
2.0
3.0
MINES PER YARD
$P_i = 1 - e^{-fd}$
f = 1.39 yds JS III
f = 1.28 yds M46
f = 1.11 yds T34/85
--- JS III
— — M46
——— T 34/85

Figure 3.

(5) A new pressure-actuated mine pattern must provide for:

(a) A density of at least one mine per yard of trace

(b) Variations in depth.

(c) Adaptability to a drill where men would carry not more than 60 pounds of mine.

(d) Adaptability to machine laying, although this has not been discussed.

(6) This new pattern should be laid in rows to permit efficient drills and machine laying. Because of sympathetic detonation distances and the cratering effect of mines containing 20 to 25 pounds of explosives, mines must be placed at least 4-yards apart. With a density of one mine per yard of front, the minimum number or rows is four. If mines are placed 4-yards apart and the mines in the second row are given the maximum offset, the minimum distance between rows is 3.4 yards. For practical purposes this should also be 4 yards. This minimum pattern would be only 12-yards deep and for this reason it is not too satisfactory.

(7) Factors determining pattern are:

(a) For a fixed density the maximum distance between mines in a row controls the number of rows. The distance between rows is effected by the methods of installation, techniques of enemy armor, and the terrain. Based on this, many patterns could be designed giving various numbers of rows at various distances and with varying distances between mines. This does not seem practical from a training standpoint and would require each individual in charge of installing a field to make a study of the situation in order to arrive at an optimum pattern. Although such a study should be made in permanent defensive positions, it is not practical for the small-unit commander desiring overnight or short-time protection. He should have a ready pattern that will serve his probably needs.

(b) It is a fact that if mines could be placed one adjacent to the other, a tank could not pass through this line without actuating a mine. The M-6 mine has a 7-inch pressure plate. If these could be placed in a line at a density of 1y mines per year of front, a tank with 20 inch treads could not get through. As previously stated mines cannot be placed in this manner because of sympathetic detonation and cratering.

(c) The primary function of the mines laid by the small-unit commander is to provide security. The field is covered by fire. It alone is not required to impose long delay on the enemy. Therefore, mines in rows should be as close together as possible. For mines up to 25 pounds of explosive this is assumed to be 4 yards. If the distance of 4 yards is fixed, the number of rows at a density of one mine per yard of front is fixed at four. A decision must then be made on distance between rows which is belt depth. Several factors previously considered, again must be weighed. Minimum depth of the belt as mentioned before is 12 yards and a known depth

is objectionable. A decision on depth is arrived at by weighing the following:

For depth	Against Depth
1. Is more difficult to breach.	1. Takes more time to lay and remove.
	2. Tanks can maneuver between rows, around tanks already destroyed.

(f) It is concluded that belts covered by fire must be narrow but not of a fixed depth. If tanks attack in column, the degree of narrowness should be that which makes a second tank susceptable to mines in the row behind that one which was detonated by the leading tank. This distance for a 20-foot tank is approximately 15 yards. (See Fig. 4). In fields of four rows, the maximum depth of the belt will be 45 yards.

Based on the foregoing, a pattern for pressure actuated mines for primary use in security and defensive fields is shown in Inclosure 2. This pattern should be prescribed as the standard pattern for pressure actuated mines.

d. Patterns for influence fused mines.

(1) Utilizing either formula discussed in paragraph 4b, it is possible to arrive at the probability of an initiation for a given type influence fuse against a given type tank.

(2) There are reasons why it is not practical at this time to arrive at a minimum density and thereby a standard pattern for influence fused mines. These are (a) the various development types of influence fuses, some of which will fire a mine outside of tracks of a tank; and (b) the various development types of mines, some of which are expected to be effective from outside of the tracks of a tank.

(3) The items furthest along in development are the T-28 single-jet shaped-charge mine and the T1209 and T1212 influence fuse. Representatives of the Ballistics Research Laboratory have stated that this mine is not effective when fired under the tracks of a tank. It is only effective against the hull. The fuses to be employed with this mine may initiate a mine 1 foot outside of the tracks of the mine. For a JS III tank, we may actuate the fuse and fire the mine over a distance of 145 inches, but this mine will be effective against only 70 inches of belly.

(4) Various developments are under way to improve this ratio. These are outlined in the presentations by Colonel Wells, Office, Chief of Ordnance, and Dr. McNish, Bureau of Standards. Until these developments have proved or disproved themselves, a standard pattern for influence fused mines should not be approved. It may develop that several densities and patterns must be developed dependent upon the characteristics of the individual mines, the fuses, and the planters.

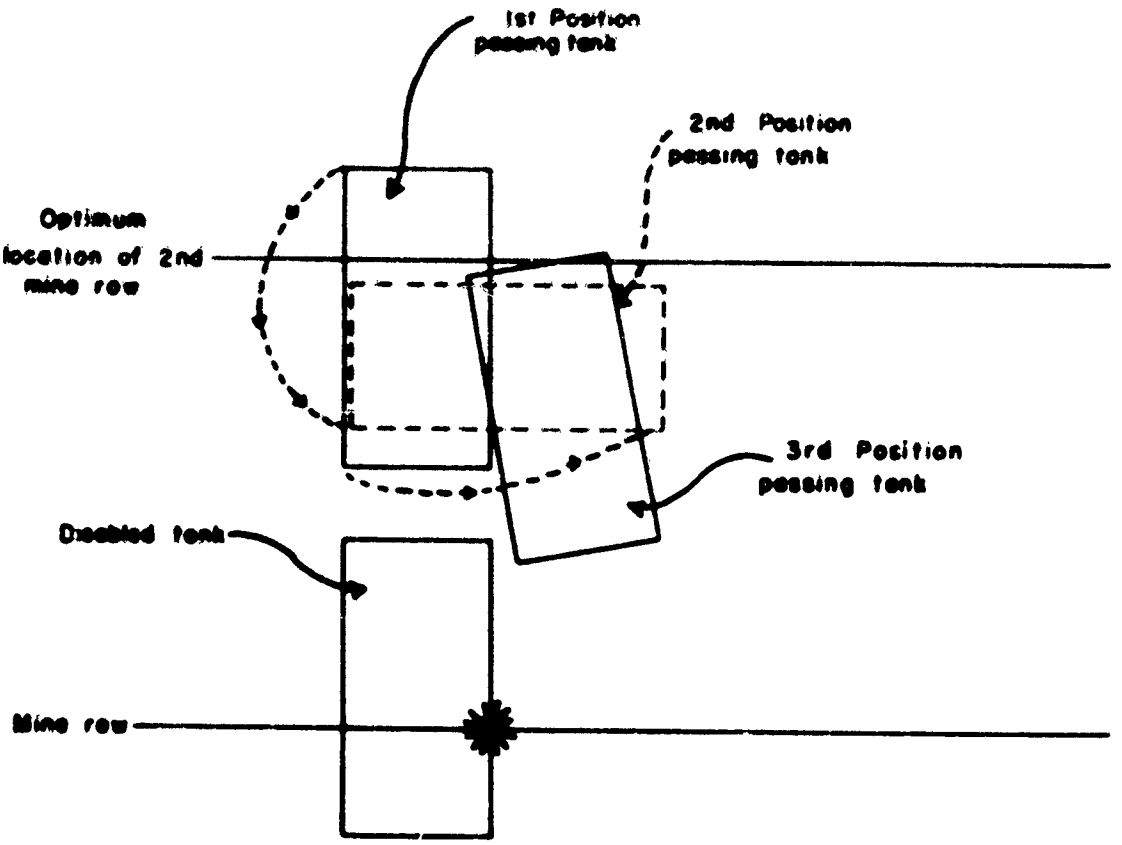

1st Position passing tank
2nd Position passing tank
Optimum location of 2nd mine row
3rd Position passing tank
Disabled tank
Mine row

Figure 4.

(5) The development attachment to the D-8 tractor for planting shaped-charge influence -fused mines has almost determined its own pattern. Because of track lengths, this apparatus can lay mines either at 3 yards or at 6 yards. Additional attachments to the track would hamper its turning ability.

(6) As discussed in previous portions of this study, mines are more effective the closer together they are planted in a row. For this reason, the spacing at 3 yards is most desirable. This would give a density of .33 mines per yard per row. A satisfactory minimum density may be achieved by planting two rows for an overall density of .67 mines per yard. Again based on the passing radius of tanks as discussed in paragraph d (6) above, the maximum distance between rows in fields covered by fire should be 15 yards. Minimum distance between rows is controlled by the ability of the planter to move safely in a row parallel to the row in which mines have already been planted and armed. This is believed to be 6 yards to allow some deviations from a straight line. The mines in the rows should receive the maximum offset. The pattern would then appear as shown below. (See Fig. 5). Recording of belts for this field should follow methods prescribed for the standard 4-row pressure actuated mine pattern.

D-8 Mine Planter Pattern

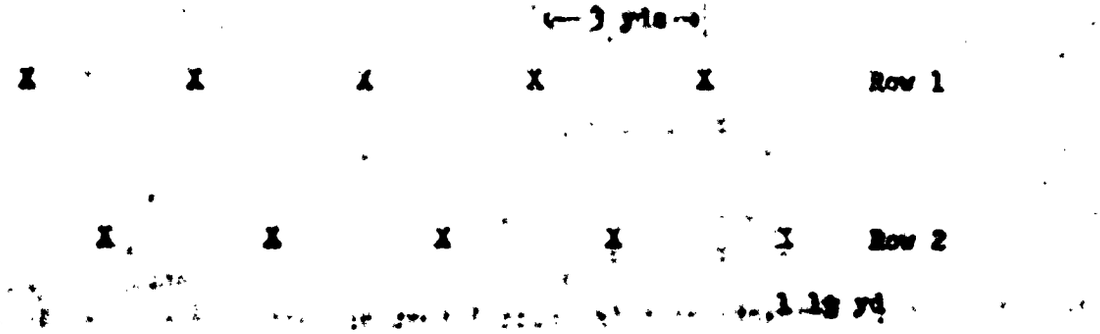


Fig. 5

g. Patterns and densities for anti personnel mine belts.

(1) Function. The anti personnel mine has two basic functions. These are to inflict casualties and to provide warning. As a result of these functions they affect enemy morale, separate infantry from armor, and make the detection of antitank mines more hazardous.

(2) Tactical use. Instances will arise where the commander may find it advantageous to use anti personnel mines in belts. These may be in tank mine fields or entirely by themselves.

(3) Density.

(a) A discussion of density for the use of anti personnel mines is somewhat academic. If trip-wired mines are used, 100 percent coverage of the front can be attained. If the enemy sees and steps over the

trip wire, the probability is zero. If he runs into the trip wire, the probability of being a casualty is a function of the effectiveness of the anti personnel mine. If it is assumed that he will become a casualty if he trips the wire, the probability is 100 percent. Where pressure-actuated anti personnel mines are used, the probability of actuation of a pattern is effected to a very high degree by the cover and concealment afforded by the terrain.

(b) The best density for trip-wire mines is to have trip wires across the entire front, with the length of trip wires equal to or less than the casualty radius of the mine. This is when casualties are the prime consideration. If warning is the prime consideration, the length of the trip wires is controlled by their ability to actuate the mine.

(c) When pressure-actuated AP mines are used to inflict casualties, the maximum density is controlled by the number of AP mines and the means of installing them. Minimum density acceptable is not readily susceptable to statistical analysis due to the use of the terrain by an attacking force and the fact that sometimes he is running and sometimes prone thereby changing the contact width. However, if belts are to be used, a minimum density should be prescribed. For pressure-actuated AP mines without trip wires, this is arbitrarily set at one mine per yard of front per belt.

(4) Triangular pattern. The present triangular pattern contained in paragraph 38, FM 5-32, May 1949 is considered as a satisfactory method of installing AP mines when using trip-wire operated mines.

(5) Pressure pattern. It is not felt that the cluster is too effective as a casualty producing belt. The first echelon of an attacking force or a mass-wave attack, if used, would wipe out the belt. A method for using pressure-operated mines is also needed. For this reason, the pattern for pressure-operated mines contained in The Engineer School Special Text 5-32-1 is recommended as an alternate method of using antipersonnel mines in belts. Extracts of this special text are attached as Inclosure 3.

(6) Employment of the two types. The following considerations govern the selection of the type of antipersonnel mine field pattern to be used.

(a) The triangular-pattern antipersonnel mine field. When properly installed, this type covers the entire front with trip wires and is principally useful in discovering and preventing the penetration of a defensive position by small enemy units of squad-size or less, such as night patrols. The normal density of trip-wire-actuated mines required to cover a front with 1 belt is 1 mine per 10 yards of front. Mine fields made up of single belts are relatively ineffective against massed infantry assault in successive waves, since the first wave will set off the majority of the mines and breach the field for following waves. Accordingly, as many belts should be installed as time and supplies permit in order to help overcome this deficiency.

(b) The pressure-pattern antipersonnel mine field. Mine fields with belts of pressure-actuated mines laid in the pressure pattern are of principal use against massed infantry assault in successive waves, particularly at night when supporting fire covering the field may not be too effective. When laid in sufficient density, there is no chance of an assaulting infantry wave passing through such a field without treading on several mines, but, at the same time, relatively few mines will be set off by each wave and the effectiveness of the field against following waves will be little reduced. This type of mine field is relatively ineffectual against penetration by small patrols, but this deficiency is largely overcome by the use of trip wires on certain of the mines. Minimum density for this type of mine belt is 1 mine per yard of front. This rule-of-thumb should not preclude laying of mine fields of greater density when labor and materials are avilable.

(c) Comparative effort. It should be noted that it requires considerable more effort and mines to install a mine field using the pressure pattern than a field using the triangular pattern. On the same terrain a 2-belt pressure-pattern field with a density of 2 pressure type mines per yard of front requires from 5 to 10 times the number of mines and from 3 to 5 times the effort that is required to install 2 triangular-pattern antipersonnel mine belts.

f. Miscellaneous methods of laying.

(1) The patterns outlined in inclosures 2 and 3 are provided for belts covered by small-arms fire. Occasions will arise when mined areas will not be covered by fire. This will make them extremely susceptible to breaching if any pattern is used. Two methods of mining may be used to hamper breaching or clearing. One is to lay the mines without any special distance between mines and not in rows, i.e., "scattered". The other is to use a quantity of antilift devices and anti personnel mines. Occasions will also arise when it will be desirable to lay mines to other than the standard patterns. This may be due to the scarcity of mines or the type of terrain.

(2) Scattered mining may be used in barrier, interdictory, and deceptive type mine fields when authorized by the commander ordering the installation. Patterns other than the standard patterns listed in incl 2 and incl 3 may be used in security, barrier, and interdiction type fields when authorized by the commander ordering the field.

(3) When scattered antitank mining is ordered for an area of great size, careful planning to include ground reconnaissance is necessary before operations are undertaken. The maximum amount of mining to be done is not to have an "X" mine per unit of terrain but "X" mine per unit of terrain over which tanks will move. As the number of mines and means of installing them are usually limited we must analyze the terrain to determine the most likely avenues of approach and establish priorities. For this reason, the primary and secondary roads should receive priority in our planning. Next, we should visualize the routes the enemy would use if forced off the roads. The planner must guard aginst mining open areas which are excellent for cross-country tank movement at the cost of lessening the effect of mining in defiles which the enemy must clear to permit passage of his forces. Close

attention must be paid to the demolition plan to insure that excessive mining is not planned for approach routes that can be effectively blocked for a sufficient time by this method. In considering the effect of demolitions, it must be expected that the enemy will have prefabricated bridging as efficient as our own. Belts of mines, except those laid axially on routes of approach, are not of high value. Their value for purpose of denying ground decrease as the depth of the belt decreases. Belts should be used rarely in areas where fields are not covered by small arms fire. The primary role of the antipersonnel mines in mining of this type is to protect the antitanks mines thereby making the antitank mine more capable of defending itself.

(4) When laying to patterns other than standard, an understanding of infantry and tank technique is required in order to determine the pattern to be used. Nonstandard pattern mining will often be used for road blocks or other occasions when the approach routes are restricted or where the number of mines is limited. Road blocks may have mines with close spacing regardless of sympathetic detonation to prevent any possible maneuvering to get through. They could have antipersonnel mines in the ditches adjacent to the road behind the tank mines to prevent accompanying infantry from moving up those covered approaches and placing fire on the defenders. For example, they may be placed in a U-formation with the open end toward the enemy and the vertical portions of the U on the shoulders so as to be effective if the tanks, warned by the disturbance of the road's surface, back up and seek some cover in the trees or embankments alongside the road. The same principles are also true in the use of nonstandard patterns for antipersonnel mines. The ingenuity of the troops installing the mines and their knowledge of enemy tactics will enable them to devise effective patterns to fit the terrain which they are defending.

(5) The standard pattern may be varied in fields not covered by small-arms fire by varying the distance between all rows up to 15 yards. If greater depth is desired, the spacing between mines in a row may be increased to 8 yards, and the number of rows increased to 8. If great depth is desired, at densities over a mine per yard of front, additional belts should be used.

(6) Route mining will utilize both scattered mines and nonstandard patterns. The biggest problem in route mining is not the location of the mines but its placement. Important highways will be hard surfaced. This may consist of 8 to 10-inch reinforced concrete or in 8 inches of stone in asphaltic highways. When extensive route mining is contemplated, provisions for breaching, scarifying, or removing this surface must be made. If this is not possible, it will be a simple problem to locate mines. In any event, disturbed areas without mines should be left to confuse and delay the enemy. A requirement exists for a means of rapid destruction of hard surface roads to enable placement of mines.

g. Patterns and density in security fields.

(1) Function of security fields. Security mine fields are used to provide local protection to small units. They are used in situations described in para (2), (3), (4), and (5) below.

(2) Pause during the attack.

(a) When mines are used in conjunction with other measures against counterattacks during a temporary pause in our attack, they will usually be used in limited quantities. This is because the number of mines is controlled by the unit's basic load. For this reason, judicious siting of the mines is of extreme importance. The anti tank mines must be used in conjunction with the antitank weapons as the density of the anti tank mine installation will probably not be of sufficient depth or density to preclude breaching or forcing by a determined enemy.

(b) The four-row pattern should be used when open fields serve as the best routes of tank approach. If the tank approaches consist of roads, straw bads, or other defiles the mines could be best used in an improvised road block pattern to give increased density.

(c) Similiarly, the anti personnel mines must be sited on the logical infiltration routes into the area. They should be trip wired mines as this gives the greatest coverage. They should be supplemented with trip flares to aid in giving warning of intruders. The anti personnel mines should be out of hand-grenade range of the individual positions. They should be sited in gullies or other places where the enemy would take cover and where it is difficult for the defender to place small-arms fire.

(3) On the defense.

(a) A greater number of mines should be available for security fields when the unit is on the defensive. Unit basic loads can then be supplemented. In a situation of this type the unit's security field may or may not be part of the defensive field of a larger unit. If it is part of such a field, then that unit may dictate patterns, densities, and to a degree, location.

(b) If this is not the case, the unit should lay its field in belts rather than in small groups as will probably be done in the pause during the attack. Belts will give better coverage of the front, insure an adequate density, and provide a means for rapid, efficient laying and easy recording. Lanes will be required for patrols and security forces. The area will probably be occupied for some time and should allow for movement of reserves and individuals during an attack. For this reason, scattered mines and individual installation of mines should be forbidden. This use of mines approaches the defensive type field.

(4) Detached Post, outpost, or working party.

(a) The detached post, outpost, or working party should be equipped with mines in sufficient quantity to help counterbalance enemy capabilities of surprising it. Working parties should have guards posted as security against enemy infiltration. As these parties will normally be active only during daylight hours, personnel mines should not be required. Anti tank mines should be placed on the more likely routes of approach. Their primary role in case of attack is to delay the enemy in order to permit the working party to organize for defense or evacuation of the area.

(b) The detached post or outpost, if required to occupy a position during the hours of darkness, should have anti personnel mines, anti tank mines, and flares. The use of these items will be guided by the same rules as outlined for the posts during the attack (par (1) (b) above).

(5) Reserve, supporting, or administrative unit.

(a) The use of mines for reserve, supporting, or administrative units approach that used by the unit when it is on the defense (par f (1) (c)). The inate requirement for units of this type to move freely in or out of their area again precludes scattered and individual installation of mines.

(b) Whether the quantity of mines be large or small they should be sited in the more likely tank approaches. If these are also the routes enabling the unit to carry out its mission, the mines will probably be stocked near these sites and only installed at night, and then under guard.

(c) As the possibility of infiltration is much less than it is when in contact with the enemy, and the amount of personnel moverent much more, anti personnel mines would not normally be used. However, the commander concerned must determine this, based on the best intelligence available.

h. Density and patterns in defensive mine fields.

(1) Doctrine specifies when and where defensive mine fields may be employed. It also specifies that they will be laid only to standard patterns. This limits them therefore to:

(a) The pressure-actuated 4-row pattern discussed in Inclosure 2.

(b) The anti personnel patterns discussed in Inclosure 3.

(c) The pattern for influence fused mines utilising the planting attachment to the D-8 tractor discussed in par f.

(2) Type of material available will determine the composition of these fields. It is not required that a single type of mine be used in each belt. A pressure-actuated pattern or an influence pattern may have anti personnel mines superimposed upon it not to pattern. Care must be taken to keep anti personnel mines forward of the row on the friendly side of the belt. For this reason, they should not be laid between rows 1 and 2 of a belt. Influence fused mines may be installed in the pressure-actuated pattern either as a substitution for pressure mines or in addition to the pressure mines. This is also true of pressure actuated mines in an influence fused belt. The primary purpose of utilising standard patterns in this type field is for efficiency of installation, thorough coverage, and to give the commander access through the area by restricting scattered mining. Scattered mining is permitted forward of the most forward row to diagram the limits of the field on the enemy side. Safe lanes

are provided through the field and will be completely free of mines. If the commander can foresee a requirement for alternate lanes, he should plan them during the installation and record the location of activated anti personnel mines in these proposed lanes to permit easy breaching. If such information is not recorded, the changing of safe lanes requires breaching the field by probing and will require considerably more time.

i. Patterns and densities of barrier fields. The function of barrier fields and their planning are discussed in other portions of the manual report. Actual installations will be of several types. They will be scattered or laid in belts to a pattern either standard or nonstandard. No specific pattern or density can be prescribed. The planner, knowing the means available, will allocate mines to an area, thereby specifying the density for a particular area. Personnel charged with installation must consider the factors outlined in paragraph f above.

j. Patterns and density for interdictory and deceptive fields.

(1) Patterns for these types of installation are not applicable. Density of live mines in a deceptive field should be extremely low when not zero.

(2) The density of an interdictory field will be based on the degree and type of interdiction desired, the type of mine and the type of fuze and the method of laying. No standard density can be prescribed.

k. Camouflage.

(1) Present standards for mine field laying include the statement that all mines be laid so that the enemy cannot readily locate the field or individual mines. This has established the requirement that individual mines and fields be camouflaged. Machine laying and the possibility of detection through aerial photographs of what appears to the eyes as a well-camouflaged installation requires that we reexamine this requirement.

(2) The Operations Research Office will publish a report in the near future which was prepared by Dr. D. J. Belcher, of Cornell University. In summary, this report will state that aerial photographs, properly interpreted are excellent means of detecting mine installations. A skilled interpreter can detect the installations by variations in tone of disturbed earth caused by the changed drainage characteristics of the soil and by the regular interruptions caused by patterns. Tracks made by vehicles and personnel cannot be successfully obliterated and serve as substantiating evidence that mines have been installed.

(3) Machine laying, using either a punch or plow method for installing the mines, must disturb the soil and the vegetation covering it. The punch principle disturbs the soil the least but does not seem to be practical for present mines. In any event, the machine itself will leave tracks. With the plow principal, it is not possible to conceal the disturbed earth. It is a basic principle of camouflage that if you cannot

hide the object, you change its surroundings to appear as much as possible like that object. If we cannot disguise the mines area, we can disguise the location of individual mines and rows. We can also make innocent areas suspect by tracks and plowing.

(4) Camouflage of mines manually installed can make them extremely difficult to detect with the human eye. Through the use of less regular patterns we can help defeat the photointerpreter. The enemy cannot photograph the entire countryside but must restrict himself to likely areas. Detection of a minefield and knowledge of its width and depth help somewhat in planning for breaching it. The basic problem is to remove the individual mine.

(5) It is concluded that although aerial photographs will aid in detecting mine installations, camouflage measures should continue to be used in manual placement. Where machine laying is used, it is not possible to use normal camouflage measures. Additional tracks and furrows not containing mines must be used to confuse the enemy as to the location of the true field and the mines in it.

5. CONCLUSIONS.

a. True randomness in laying of mines cannot be obtained.

b. The random probability theory for analysing the effectiveness of mine field density is adequate for all practicable purposes and is more conservative than other probability approaches.

c. Laying to pattern has advantages and disadvantages. A drill providing for some variation in a standard pattern is an improvement over present fixed patterns.

d. Development influence fuses and development mines have variable characteristics which make it inadvisable at this time to determine a standard pattern based on an optimum density.

e. Present patterns and densities for personnel mines prescribed in FM 5-32 "Land Mine Warfare", and the Engineer School Special Text 5-32-1 "Procedures for Installing and Recording Antipersonnel Mine Fields" are adequate.

f. Under certain tactical situations it is often desirable to lay mines without pattern to realize their maximum effectiveness.

g. The minimum acceptable density for antitank mine belts using pressure actuated mines laid to pattern is one antitank mine per yard of front.

h. Tactical requirements of functional fields as proposed by this panel will require judicious scattering of mines and laying mines to standard and nonstandard patterns.

i. Extensive route mining of major highways is extremely time consuming when utilizing existing equipment and/or explosives.

j. Camouflage of individual mines should be continued where practical. Where machine laying makes it impractical to camouflage the mine installation, areas not containing mines must be made suspect by marking similiar to that made by machine laying.

k. The specific purpose of an interdictory field, the type of mines and fuses used and the methods of installation all have a bearing on density. No particular density can be prescribed as standard, however, individual spacing of antitank mines may vary from about 15 yards to sympathetic detonation range and in general, antipersonnel mines should protect each antitank mine.

6. RECOMMENDATIONS

a. That a density of one antitank mine per yard of trace of a mine belt be adopted as the minimum essential requirement for fields laid to pattern.

b. That the pattern and drill discussed in appendixes C and E be adopted and standardized for use in those installations where standard patterns are required.

c. That the principles to be observed for nonstandard pattern and scattered mine laying discussed in appendixes C and E be approved.

d. That a method and/or equipment be developed to enable the rapid placement of large quantities of mines in major highways.

e. That Section II Appendix E be used as a basis for revising portions of Chapter 3 FM 5-32

INCLOSURE I

SCATTERED LAYING

1. The following instructions were given to the personnel of the 91st Engineer Construction Battalion who performed the tests.

"1. The purpose of this test is to determine:

a. The speed of installing a mine belt laid without pattern versus the six-row antitank pattern.

b. The thoroughness of the coverage received from laying without pattern in a given area.

2. To achieve this purpose the following tests will be run.

a. Four tests, laying 150 mines without pattern in a strip of ground 100 yards long and 100 yards deep. The boundaries of the area should be marked. Mines should be stacked 75 in a stack at 2 sites equidistant along the "friendly" side of the mine field in two of the drills and in four stacks for the remaining two drills. Troops should be organized into two squads, each squad working from one mine stockpile. Sufficient instruction should be given the troops to prevent them from laying the mines closer than 4 yards apart and to insure that they understand that thorough coverage of the area is desirable. They should also be aware that although this is not a speed test for either method, comparisons of time will be made.

Each installation will be timed and the location of all mines in the area recorded as accurately as platoon equipment will permit.

b. Two tests will be made laying the six-row antitank pattern. Troops laying the field should not receive any rehearsals in laying this pattern. Each installation will be timed but records will not be kept. Again mine dumps of 75 mines should be placed equidistant on the friendly side of the field.

c. In neither tests will mines be buried or the fields marked. Time spent in recording mines will not be kept.

3. Report should consist of:

a. Sketches to scale showing location of mines placed in each nonpattern belt.

b. Time spent laying each installation".

2. Time of laying was as follows

Test 1	Scattered	24 minutes	
2	"	28 minutes	
3	"	12 minutes	(4 stacks)
4	"	14 minutes	(4 stacks)
5	6 Row Drill	11 minutes	
6	" " "	14 minutes	

The reasons given for the 50 percent reduction in time required to lay fields 3 and 4 compared with 1 and 2 are:

a. The 2 additional dumps required less walking on the part of the men. (The time required to set up the dumps is not included).

b. The men were more aware of what was to be done.

c. The officer and NCO supervised less, and depended on the men themselves to achieve thorough coverage.

3. Charts showing the number of mines placed in each 10-yard square are attached. The detailed records showed that mines were usually not close enough together to cause sympathetic detonation.

TEST I

TIME REQUIRED : 24 MINUTES
DIMENSION OF FIELD : 100 X 100 YARDS
NUMBER OF MINES : 150
NUMBER OF DUMPS : 2

NUMBER OF MINES										
7	1	1	2	0	0	1	0	1	0	1
17	1	2	3	2	2	0	2	1	2	2
17	1	1	1	2	2	2	2	2	2	2
10	1	1	1	0	2	2	1	1	0	1
12	0	2	0	2	1	1	2	1	1	2
16	2	1	1	2	2	2	1	1	2	2
12	0	1	1	1	2	2	1	1	2	1
15	1	1	1	2	3	1	1	1	2	2
16	1	2	1	2	2	2	2	1	2	1
28	1	3	3	3	4	4	4	3	1	2
NUMBER OF MINES	9	15	14	16	20	17	16	13	14	16

TEST II

TIME REQUIRED : 28 MINUTES
DIMENSION OF FIELD : 100 X 100 YARDS
NUMBER OF MINES: 150
NUMBER OF DUMPS: 2

[illegible]										
3	0	0	1	1	1	0	0	0	0	0
7	1	1	2	0	2	0	0	1	0	0
13	1	2	2	1	2	2	0	2	0	1
13	1	2	1	1	1	2	2	2	1	0
16	2	1	1	1	2	2	1	3	0	3
19	2	2	2	0	2	3	2	3	2	1
13	1	2	2	1	1	1	0	1	2	2
16	2	1	1	1	2	2	1	2	2	2
22	2	2	2	1	2	3	1	3	3	3
28	3	3	3	2	3	3	2	3	3	3
[illegible]	15	16	17	9	18	18	9	20	13	15

TEST III

TIME REQUIRED : 12 MINUTES
DIMENSION OF FIELD : 100 X 100 YARD
NUMBER OF MINES : 150
NUMBER OF DUMPS : 4

NUMBER OF RISKS										
5	1	0	0	2	0	1	0	0	0	1
6	1	0	2	1	0	1	0	0	0	0
11	1	2	0	1	1	1	1	1	1	2
13	1	1	1	1	2	1	0	3	1	2
19	1	1	4	3	1	2	2	1	2	3
20	1	2	3	3	1	3	2	1	2	2
16	1	2	1	1	1	3	1	2	0	2
16	1	3	1	3	1	3	1	2	0	1
22	1	3	2	3	1	1	2	4	3	2
22	2	2	4	2	2	2	1	3	3	1
NUMBER OF MINES	11	16	18	20	10	18	11	16	14	16

TEST IV

TIME REQUIRED : 14 MINUTES
DIMENSION OF FIELD : 100 X100 YARDS
NUMBER OF MINES : 150
NUMBER OF DUMPS : 4

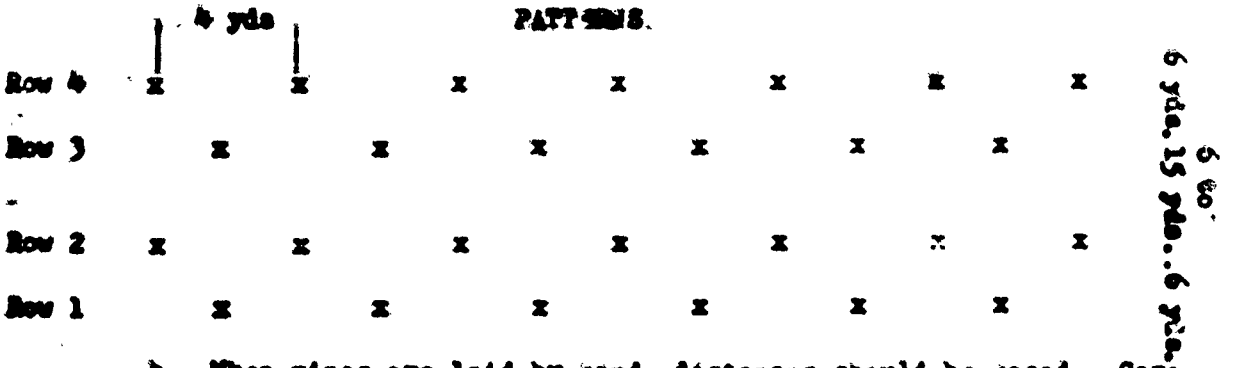
NUMBER OF MINES										
13	1	0	1	0	1	2	2	1	3	3
13	1	1	1	2	1	1	2	0	1	2
11	1	1	1	1	1	1	2	0	2	1
16	1	2	2	2	2	3	0	2	1	1
14	1	2	2	1	3	1	1	1	0	2
13	1	1	1	2	1	1	1	1	2	1
16	1	1	3	2	2	1	2	2	1	1
12	0	1	2	1	1	3	0	2	2	1
16	1	1	2	3	3	1	1	1	2	1
26	2	3	2	3	3	3	3	3	2	3
NUMBER OF MINES	10	13	18	16	18	18	14	12	16	16

Incl 2

1. Basic Mine Belt pattern.

a. Mines are laid in four rows. Each mine in a row is 4 yards apart. The two rows on the enemy side of the field (row 3 and 4) are 6 yards apart. Row 2 is a variable distance of from 6 to 15 yards from row 3. Row 1 is 6 yards from row 2. Mines in rows 1 and 3 are offset from mines in rows 2 and 4.

PATTERNS.



b. When mines are laid by hand, distances should be paced. Care should be taken to avoid laying mines in straight line.

c. Drill for laying basic pattern with 30 pound mine follows:

Personnel	Equipment	Duties
Officer in Charge	Map, lensatic compass, notebook, mine-belt report	Supervise beginning of work, to include, location number and types of mines to be laid and estimated time of completion. Locates trace of mine belt, right boundary, determines distance between rows 2 and 3 and locates mine-field safeguards (signs and fences). Disignates locations of topographic markers and location of auxiliary markers. Collects all safety forks from squad leaders and has them buried beside right rear mine of each section. Makes initial report as soon as work is under way. Makes location report of the mine field. Collects

Personnel	Equipment	Duties
		and verifies all records, verifies number of mines laid, turns-in records, and reports completion of task to proper higher authority.
Platoon sergeant	Map, notebook, lensatic compass	Acts as second in command keeps information so he can replace officer if latter becomes a casualty. If mines are to be activated, designates their location to squad leaders. Supervises establishment of mine dumps
First squad (Siting party)	Long stakes or pickets 4 feet long and means of installing these in ground	As directed by the officer in charge, NCO has a picket installed for row 1 and one for row 3 at the boundary of the belt. He then directs that stakes or pickets be placed every 100 yards, or when the officer in charge indicates that the belt changes direction. The pickets or stakes must be visible to a standing man at a distance of 100 yards. At night tracing tape should be installed from these guides markers to the next guide marker. He also has installed metallic right rear reference marker within 15 yards of the right rear mine. A marker of this type is installed each 100 yards or when the belt changes directions

Personnel	Equipment	Duties
Marking party (3 men)	Fencing materials, triangular signs wire cutters, gloves and sledges	Erect marking fences and signs as directed by officer in charge.
Recording party (1 NCO and 2 men)	Sketching equipment, including lensatic compass and metallic or steel tape, record forms map	Fill out record forms as directed by officer in charge
Second squad (laying and burying party)	Squad Leader: Notebook Layers: Mines Armers: Fuses in sandbag Entire squad: Picks, shovels, and sandbags for burying mines	Carry mines from dump, and lay, arm, and bury all mines in rows 3 and 4 Detailed duties as follows: Squad leader: General supervision of squad: collects safety forks from armers on completion of each section; verifies number of mines laid and turns over safety forks to officer in charge Assistant squad leader: Starting from picket indicating row 3, steps off 4 paces and indicates to layer to place mine near that point. Proceeds to second guide post indicating a mine location at every 4th pace Layers: Each man gets 2 mines from the dump and reports directly to assistant squad leader. Within 3' of the location indicated by the assistant squad leader, he places one mine. He then takes 6 paces toward the enemy side of the field and two paces in the direction the belt is being laid and lays his second mine. He returns to the dump and repeats this procedure.

Personnel	Equipment	Duties
		Armers: Each armer is assigned one row. If mines are to be laid on surface, he conceals them as best he can. He counts the number of fuses in his sanibag before starting and after finishing a section. He checks any difference against the number of mines laid. Safety forks are turned over to the squad leader
All		When all mines have been laid and armed, the entire squad buries the mines. (If anti-tank mines are to be activated, the mines designated by the platoon sergeant are left unburied). The mines may be laid and buried a section at a time, or the entire belt may be laid first and then buried. When antipersonnel mines are superimposed on the belt it is done after the un-activated mines have been buried
Third squad (laying and burying party)	Same as for second squad	This squad is responsible for rows 1 and 2. Duties and procedures are the same as for the second squad. This squad does not start until the second squad has about 20 yards of their rows laid. This prevents having men in second squad walk through mines in rows 1 and 2 on way from dump.
		When the belt has been completely laid and recorded, all guide posts are removed. All double crossing wires operation wire also to be used.

1. Drill for laying basic pattern with 20 pound mine follows:

Personnel	Equipment	Duties
Officer in Charge	Map, lensatic compass, notebook, mine-belt report	Reports beginning of work to include location, number and types of mines to be laid and estimated time of completion Locates trace of mine belt, right boundary, determines distance between rows 2 and 3 and locates mine-field safeguards (signs and fences) Designates locations of [illegible] and location of auxiliary markers. Collects all safety forks from squad leaders and has them buried beside right rear mine of each section. Makes location report of the mine field. Collects and verifies number of mines layed, turns in records, and reports completion of task to proper higher authority
Platoon sergeant	Map, notebook, lensatic compass	Acts as second in command. Keeps information so he can replace officer if latter becomes a casualty. If mines are to be activated, designates their location to squad leaders. Supervises establishment of mine lanes.
Patrol squad (Siting party)	Long stakes or pickets 4 feet long, and means of installing these in ground	As directed by the officer in charge. NCO has a picket installed between rows 1 and 2 and one between rows 3 and 4 at the boundary of the belt. He then directs that stakes or pickets be placed every 100 yards or when the officer in charge indicates a change in direction of the belt. The pickets or stakes must be visible to a standing

Personnel	Equipment	Duties
		man at a distance of 100 yards. At night tracing tape should be installed from these guide markers to the next guide marker. He also has installed metallic right rear reference markers within 15 yards of the right rear mine. This kind of marker is installed each 100 yards or when the belt changes direction
Marking party (3 men)	Fencing materials, triangular signs, wirecutters, gloves and sledges	Erect marking fences and signs as directed by officer in charge
Recording party (1 NCO and 2 men)	Sketching equipment, including lensatic compass and metallic or steel tape, record forms, map	Fill our record forms as directed by officer in charge
Second squad (laying and burying squad)	Squad leader: Notebook Layers: Mines Armers: Fuses in sandbag Entire squad: Picks, shovels, and sandbags for burying mines	Squad leader: General supervision of squad: collect safety forks from armers on completion of each section; verifies number of mines laid and turns over safety forks to officer in charge. Assistant squad leader: Starting from picket between rows 3 and 4 he has his layers form in two lines, 6 yards apart, behind him He then steps off two paces and indicates left. The layers in the two lines move with him. The layers on the left places his mine when indicated. The assistant squad leader steps off two more paces and indicates right. The layer on his right places his mine. He repeats this process the length of the belt.

Personnel	Equipment	Duties
		Layers: Each man gets 3 mines from the dump and falls in on the two lines indicated by the assistant squad leader. Taking care to keep 6 yards from the man in the next row he places his mines as indicated by the assistant squad leader. He avoids placing his mines in a straight line. After he has laid his third mine he returns to the dump and repeats the procedure.
		Armers: Each armer is assigned one row. If mines are to be left on surface, he conceals them as best he can. He counts the number of fuses in his sandbag before starting and after finishing a section. He checks any difference against the number of mines laid. Safety forks are turned over the squad leader. When all mines have been laid and armed, the entire squad buries mines. (If antitank mines are to be activated, the mines designated by the platoon sergeant are left unburied). The mines may be laid and buried a section at a time, or the entire belt may be laid first and then buried. When antipersonnel mines are superimposed on the belt it is done after the unactivated mines have been buried.

Personnel	Equipment	Duties
Third squad (Laying and burying party)	Same as for second squad	This squad is responsible for rows 1 and 2. Duties and procedure are the same as for the second squad. This squad does not start until second squad has about 20 yards of their rows laid. This prevents having men in the second squad walk through mines in rows 1 and 2 on way to and from dump
All		When the belt has been completely laid and recorded, all guide markers are removed. All debris resulting from operation also must be removed.

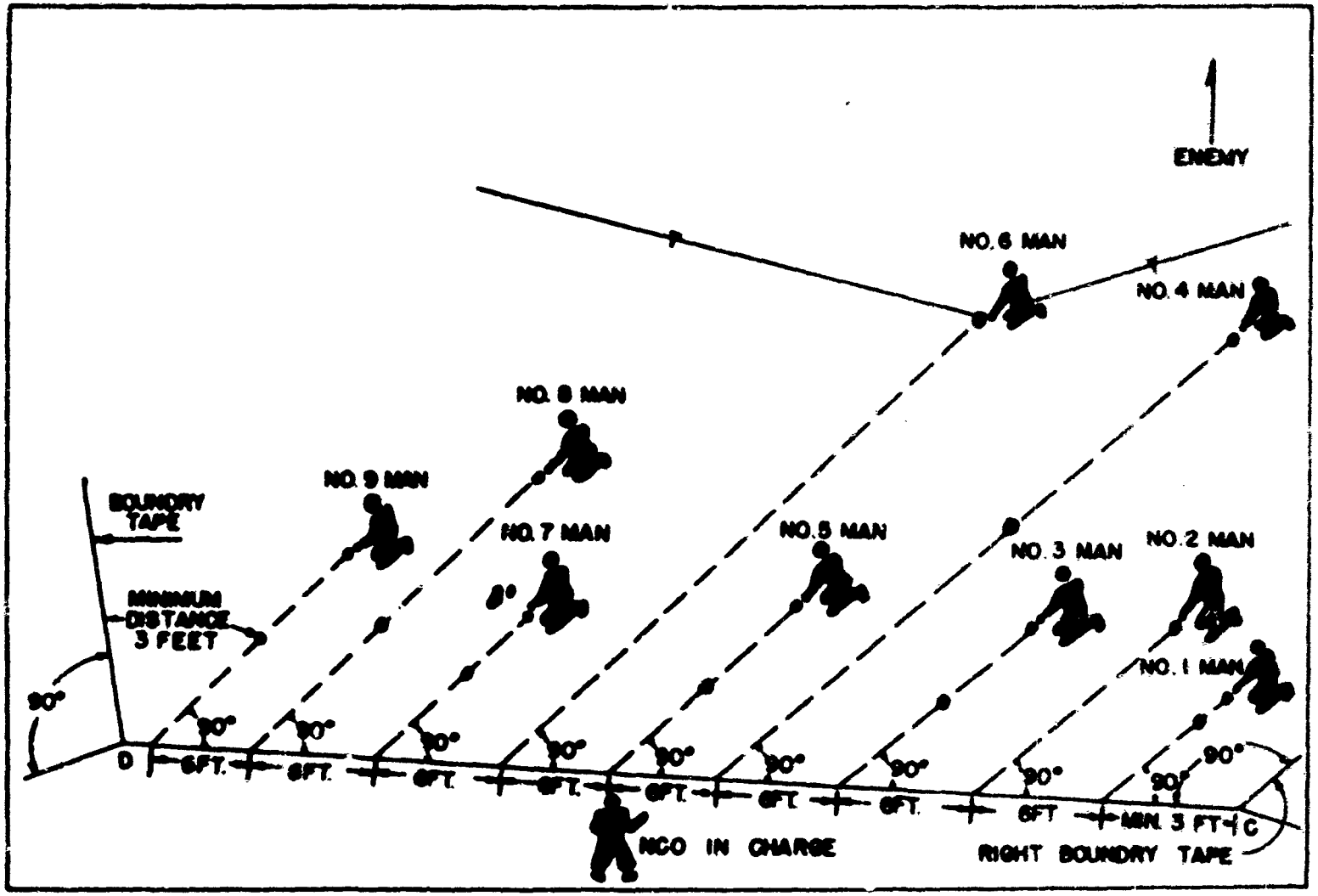
Incl 3

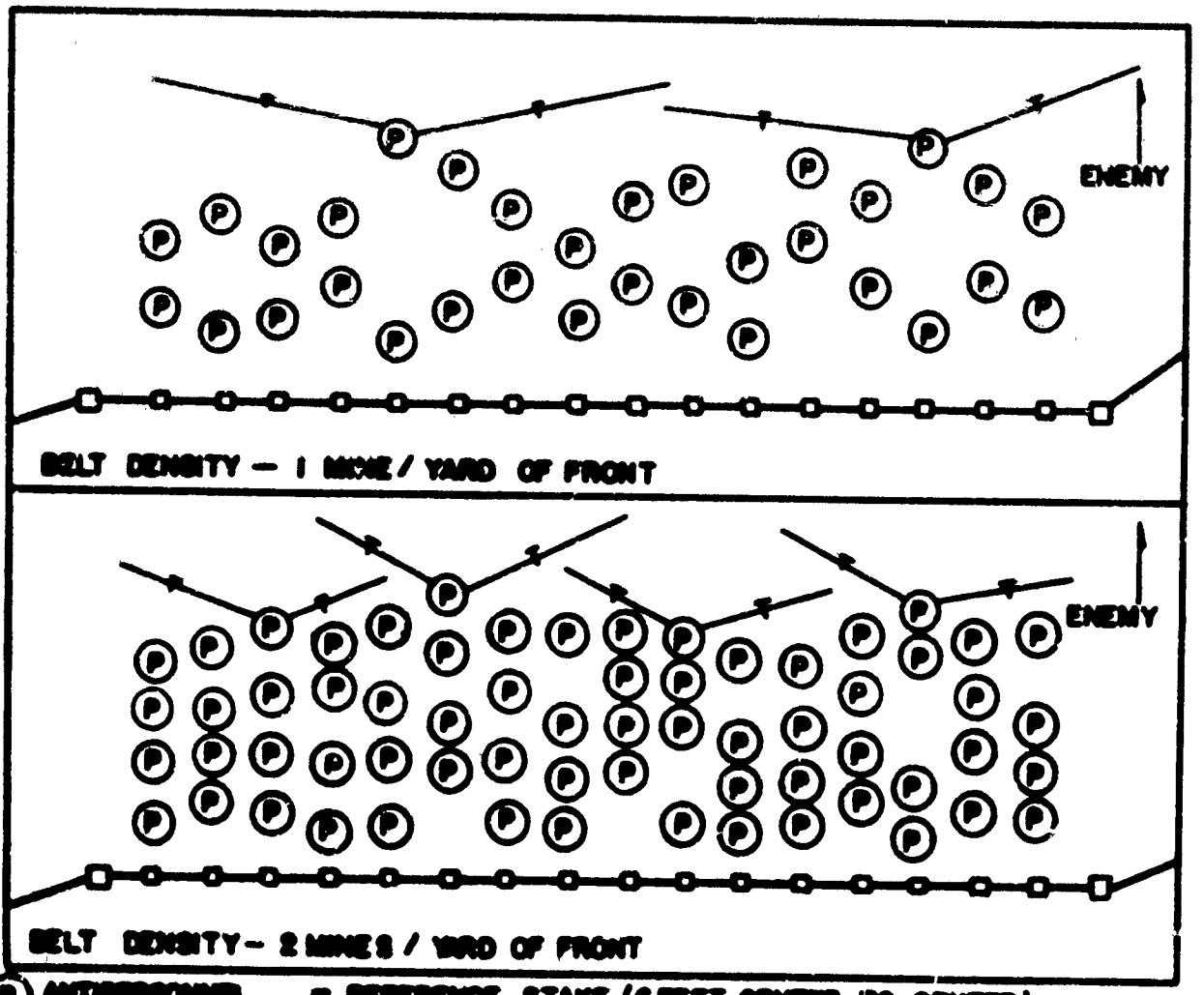
Pressure Pattern Personnel Belt

THE PRESSURE-PATTERN ANTIPERSONNEL MINE BELT

1. a. The pressure pattern for an antipersonnel mine belt is used when the belt consists mainly of pressure type antipersonnel mines. The pattern is designed so that a belt can be safely and quickly laid, simply recorded, and safely removed. The pattern is laid to a reference line and can form sections of variable length to fit the terrain.

b. The pressure-pattern antipersonnel mine section. The pressure-pattern antipersonnel mine section consists primarily of pressure type antipersonnel mines laid on the enemy side of a reference line along lines perpendicular to the reference line at 6-foot intervals. One or more mines may be placed along each perpendicular line at various intervals to obtain desired density. The distance of the first mine from the reference line varies, but is never less than 6 feet and usually not more than 30 feet. The same number of mines is normally placed along each perpendicular line to maintain a uniform section density, but the density of a section may be increased where the belt passes through the most likely area of anticipated enemy penetration.


ENEMY
NO. 6 MAN
NO. 4 MAN
NO. 8 MAN
NO. 9 MAN
BOUNDRY TAPE
NO. 7 MAN
NO. 5 MAN
NO. 3 MAN
NO. 2 MAN
MINIMUM DISTANCE 3 FEET
NO. 1 MAN
90°
D
6FT.
NCO IN CHARGE
MIN. 3 FT
RIGHT BOUNDRY TAPE


ENEMY
BELT DENSITY — 1 MINE / YARD OF FRONT
ENEMY
BELT DENSITY — 2 MINES / YARD OF FRONT
(P) ANTIPERSONNEL
TRIP WIRE
REFERENCE STAKE (6 FEET CENTER TO CENTER)

APPENDIX D
MINE FIELD CLEARANCE

1. PROBLEM. To study existing methods which are used in locating mine fields, reconnaissance of enemy mine fields, assault breaching, route and area clearance, and the utilization of equipment to include detectors, explosive devices, and mechanical eradicators which are either standard or under consideration and/or development.

2. ASSUMPTIONS.

a. Mine detection and clearing devices, and related methods to be available in the near future, will provide only marginal improvement over currently available materiel and methods.

b. Improved doctrine and technique in the employment of even conventional materiel will result in the more effective clearance of mine fields.

c. Development of items of mine warfare materiel will progressively contribute to the effectiveness of mine field clearance.

3. FACTS. Present mine clearance doctrine is contained in FM 5-32, May 1949.

4. DISCUSSION.

a. General principles.

(1) Organizational responsibilities. Tactical units breach or clear mines only to the extent necessary for their continued movement and operation. It is the responsibility of the tactical unit commander to effect this necessary clearance. Thus, a division, regiment or task force should clear only those mines that interfere with the tactical employment of the unit. Corps units extend mine clearance to ditches, fences, hedgerows, buildings, or to four feet beyond the road shoulders, whichever occurs first. Corps units also clear main turn-outs, parking areas along roads, and assigned areas such as airstrips, bivouac areas, or similar installations. Army units clear all additional areas necessary for the operation of the army. Other areas may be cleared for later civilian use, and this clearance may be completely under civilian control.

(2) Responsibilities of various arms. Fewer casualties will result when each arm and service is trained to conduct the mine clearing necessary for its own operations. All troops must maintain proper mine discipline in proximity to mines. Mine discipline includes training to observe mine warnings, to avoid doubtful areas, and training in manual clearing methods. Familiarization with enemy mines and mine tactics is also neces-

(a) Infantry. Infantry must support and protect engineers in major mine field breaching operations. When necessary, engineers may be called upon to furnish mine reconnaissance parties for the advance elements of the Infantry, but infantry must be able to advance through mined areas without the aid of Engineers.

(b) Armored units. Tank mines are a major hazard and render tank support extremely difficult in some operations. To reduce the number of armored vehicle casualties constant and through reconnaissance must be made on all routes of approach, particularly in areas suspected or known to be mined. Units supported by tanks should aid and guide tanks through known mined areas.

(c) Field artillery. Special mine clearance detachments move forward with the reconnaissance parties to clear mines in advance of the arrival of the remainder of the artillery unit. Routes to and from the area will be cleared thoroughly and other areas will be cleared as necessary. Cleared areas will be carefully marked to indicate usable areas.

(d) Navy responsibilities. The navy will be called upon to clear mines from the deep water approaches to landing beaches. Underwater demolition teams may be called upon to clear shallow water mines. Landing force engineers must be prepared to assume this task. Mine clearing parties for clearance of beach mine fields will be transported in the early waves of landing craft to insure early movement across the beaches. Lanes must be marked and signs posted rapidly.

(e) Service units. These units must be responsible for mine clearance operations in their own bivouac and work areas. All personnel must be familiar with enemy mine tactics to be able to avoid suspected and marked areas.

(3) Types of clearing operations.

(a) Assault gapping. Assault gapping is the breaching of one or more lanes through a mine field. Methods employed are influenced by the types of mines encountered in the mine field and tactical necessity.

1. Siting and camouflage of mine fields and the extent of information gained before breaching operations will influence the choice of breaching method to be employed.

2. Numbers and types of activated antipersonnel and antitank mines and the depth of field also must be considered in breaching plans.

3. The availability of mechanical or explosive breaching devices may dictate the breaching method to be used.

4. Mine fields defended by small arms and anti-tank fire require neutralization of such fire before or concurrent with the breaching operation.

(b) Secret breaching. Since the enemy normally observe their mine fields closely, it is difficult to breach paths secretly. Full use must be made of smoke, darkness, and fire support to avoid detection by the enemy. Every effort must be made to prevent the enemy from gaining knowledge of an impending assault. Disclosure of breaching plans might permit the enemy to improve his defense, including the reinforcement of his mine fields. Secret breaching or assault gapping can be accomplished by probing, with or without the assistance of electrical mine detectors. Probing is generally considered to be the most accurate but most time consuming of several means employed to detect and clear mines secretly. Narrow lanes are cleared of mines, usually during the hours of darkness preceding an attack. A bridgehead may be formed to protect the cleared lane. Gaps covered by bridgeheads are widened as quicly as possible to allow additional troops through in order to maintain the momentum of the assault. Electrical detection in conjunction with probing can be used to increase speed. When detectors are used the exact location of the mines is determined by probes. Probing, with or without the use of electrical detectors, is not fool-proof and care must be taken not to overlook deeply buried antitank or probe-proof and care must be taken not to overlook deeply to detect even by careful probing. When probe-proof mines are encountered, manual clearing methods should be employed only as a last resort. If no other clearing methods are available, areas containing this type of mine must be cleared by probing every 1½ to 2 inches of ground area. Probes will not normally reach deeply buried mines, but it is possible that loosened or disturbed earth may be detected above such enemy mines. Electrical detectors transmit signals which might actuate induction type fuses.

(c) Full fire and air support, including use of smoke, may be necessary for breaching operations. When reconnaissance shows that enemy mine fields are well protected with antipersonnel mines and will be difficult to breach secretly, other methods must be used. Explosive or mechanical methods are rapid and are used when other methods are impracticable or when time is an essential element. Every effort is made to preserve secrecy until just before the attack is launched. Coordinated air attacks may be employed and light aircraft may be used to direct fire on hostile positions. Explosive methods may be followed up with roller eradicators to eliminate mines that are not cleared by explosives because of the "skip" effect of most explosive clearing devices or other causes.

(4) Route clearing. Route clearing is a continuing operation and all roads must be continually checked against reinining by guerilla forces or patrols. Road clearing detachments move with forward combat troops and other clearing parties periodically recheck previously cleared routes.

1. Enemy mine fields for which no records are available other than information reports from combat troops that have previously passed through.

2. Clearance of mine fields previously laid by friendly troops and which may or may not have been recorded.

3. Clearance of friendly mine fields which temporarily may have been under enemy control, or subjected to artillery fire.

(b) Post-war clearance. This is the continuation of postoperation clearance as noted above, and includes the clearance of all mines necessary for normal civilian activities. This may be accomplished entirely under civilian control.

b. Reconnaissance. Reconnaissance will start immediately after detection of a hostile mine field and will be as thorough as the situation will permit.

(1) Reconnaissance information required. This information includes the following:

(a) Depth and length of field is important in the preparation of plans and in deciding what breaching method or methods are to be used.

(b) Probable positions, and location and types of enemy weapons must be determined to permit preparation of support plans for the breaching operation.

(c) The location of possible bypasses is extremely important because costly and time-consuming breaching operations may be avoided.

(d) Information, such as metallic, nonmetallic, antipersonnel, antitank or activated mines about to be encountered is valuable to a commander who has to decide the best method to breach a mined area.

(e) Patterns and densities of enemy mine fields determined by reconnaissance patrols may indicate the location of antitank, antipersonnel and activated mines, and thus show the pattern used. This may also dictate the breaching method to be used, and may simplify and speed the breaching operation.

(f) Information concerning obstacles, such as tank ditches, barbed-wire entanglements, terrain features, and road craters is important.

(2) Methods of obtaining information.

(a) Visual aerial observation, and study of aerial photographs of suspected areas may give indication of depth and extent of mine fields. Aerial observation may disclose routes most advantageous to the attacking force, locate hostile positions and weapons, and give information about other obstacles and enemy activity.

(b) Trained aerial observers may be able to detect mines by visual observation.

(c) Study of captured enemy maps, and interrogation of prisoners and local inhabitants may provide valuable information.

(d) Combat patrols may give information about barriers and enemy troops which will be valuable in planning the assault gapping.

(e) Mine field reconnaissance patrols provide valuable information. Probing can be carried out with great secrecy and is usually considered more accurate than electrical detector methods in soils of high magnetic susceptibility. The electrical detector method is considered reasonably accurate in locating metallic and nonmetallic mines. The operator must be well trained to gain speed in evaluating the signals given off by the detector. Probing must be used with the electrical detector method of pinpoint mine locations.

(f) A suggested organization for a mine field reconnaissance patrol is one officer or noncommissioned officer and six enlisted men, three of whom are armed with carbines or submachine guns. The remainder of the party are armed only with hand grenades. All personnel are equipped as lightly as possible. The party is organized to reconnoiter a three-to-six-foot path through a mine field starting at a predetermined point and ending when the enemy side of the field is reached or when enemy action stops further penetration. The patrol examines all mines and booby traps in its path and if possible brings back at least one mine of any type encountered, when knowledge of the characteristics permits safe removal. A centerline tape with knots indicating location and types of various mines found constitutes the record of the patrol. Each knot represents a certain type of mine or fuze as follows:

Trip wire - one knot.
Antipersonnel mine - two knots.
Antitank mine - three knots.
New type of mine - four knots.

Ordinary shipping tags may be used instead of knots to indicate mines or trip wires located. Information is written on the tag which is then fastened

to the centerline tape. An improvised code may be used to mark tags in order to save time and make marking easier at night. The knotted tape or marked tags brought in by reconnaissance patrols give valuable information concerning the enemy mine field. When laid out on the ground in a rear area they provide a means of reconstructing relative locations of mines by type and trip wires. When several of these tapes are incorporated on a sketch of a mine field area, they may give an indication of the mine field pattern. The greater the number of reconnaissance tapes completed the more accurately the mine field can be plotted and the more effectively the breaching plans can be prepared.

c. Effects of composition (types of mines) of mine fields on breaching methods. When information is available as to types of mines in a mine field, breaching operations may be greatly expedited.

(1) Probe-proof antipersonnel mines. When this type of mine is detected it is impracticable to probe because of the hazards and time involved. If no other detection means are available and operations must be carried out in secrecy, the probing method is used with extreme care. If secrecy is not essential, explosive or mechanical methods may be used. If only antipersonnel mines are present in the mine field, tanks, rollers, or flails can breach paths ahead of the infantry.

(2) Nonmetallic mines. These mines can be detected by electrical detectors if small mines are not buried too deeply. Operators can improve their ability, through training, to discriminate between false and true signals. Many signals must be further investigated by probing to determine whether they are actually true or false. When small nonmetallic antipersonnel mines, which cannot be detected by electrical detectors, are planted to protect antitank mines, commanders must resort to other methods of breaching. Explosive methods may be used and followed up with flails or roller eradicators.

(3) Breach-proof mines. These mines are usually of heavy metallic construction and can be detected by electrical detectors or by probing. These mines may also be cleared by any displacement device such as mine clearing plows.

(4) Antitank and antipersonnel mines, separate, mixed, or in adjacent belts.

(a) Antitank mines. Antitank mines alone can be detected by probing or by electrical detectors and can be hand lifted or removed by rope, if activated. After the mine is removed, the hold must be checked with detector or probe to ascertain that not more than one mine was laid in the hole.

(b) Antipersonnel mines. These mines can usually be detected by electrical detectors or probing. When mines cannot be detected they may be eradicated by explosive or mechanical devices.

(c) Mixed antitank and antipersonnel mines. If mechanical devices, effective against both antitank and antipersonnel mines are not available, antipersonnel mines may first be eliminated by explosive methods then unexploded antitank mines are removed manually. Entire manual clearing may be necessary.

(4) Selection of breaching method. The breaching method is selected after consideration of the following factors, listed in order of importance:

(1) The mission of the command and particularly with respect to requirements for time and extent of clearance required.

(2) The availability of troops and breaching equipment.

(3) The hostile defense of the mine field and friendly offensive capabilities.

(4) The types of mines present in the field to be breached, or the composition of the field.

e. Details of methods.

(1) Manual. Because present standard detectors are not entirely satisfactory under all conditions, detectors must be supplemented with probing and visual detection in areas suspected of containing nonmetallic and small antipersonnel mines.

(a) Probing. Mines usually can be located readily by mine probes, bayonets, or stiff wires. When bayonets are used, extreme care must be exercised to avoid detonating Schu-mine type antipersonnel mines. In the absence of reliable nonmetallic mine detectors, probing is generally the best way to locate nonmetallic antitank and antipersonnel mines. Most mines can be located by the prober as he crawls forward on his hands and knees, feeling and probing. The hands and arms (sleeves rolled up) are used to find trip wires and pressure type antipersonnel mines. In probing, the probe is pushed into the ground at an angle less than 45 degrees to avoid setting off sensitive antipersonnel mines. In searching an area one man should cover about one yard of front, probing every 1½ to 6 inches (depending on the type mines encountered) and before he moves forward feeling with hands and arms for trip wires, pressure fuses, and mines laying on top of ground. The mine probe, M1, is normally used without the extension when probing from the kneeling position. The extension is used in pot holes, road shoulders, foot paths and in brush. The short probe should be used whenever possible keeping the body near the earth and as far as possible away from the mines being probed. To avoid detonating the mines, the probe should be pushed, but not jabbed, into the ground.

(b) Detectors (electrical). The use of electric mine detectors is the most rapid available way to locate individual metallic mines. Mine detectors can locate either metallic or non-metallic mines but all detectors have their limitations with respect to false signals, depth of detection and operation over certain types of soil. The SCR-625 (TM 11-1151) is an excellent detector and will detect mines containing metal, but will not detect nonmetallic mines or trip wires unless the searchhead is directly over the wire. The SCR-625 is very light in weight and can be operated from the prone or kneeling position. This detector is not waterproofed and should not be submerged. The AN/PRS-3 reliably detects metallic mines, and nonmetallic mines having metallic content. This detector locates other small metallic fragments. This detector is immersion proof and can be operated in water. The AN/PRS-4 is an ultra high-frequency detector and is capable of detecting metallic or nonmetallic antitank mines in seven inches of soil, except dry sand and gravel, and antipersonnel mines in two inches of soil when the mines are as large as four inches in diameter. This detector is subject to false signals from air pockets, rocks, roots and when the search head is tilted from the horizontal plane. The detector should be operated with the searchhead 0 to 3 inches above the ground. Effective use is extremely dependant upon the state of training of the operators. Untrained operators are of little value because proper interpretation of signals given by the detector is vital to its successful use.

(c) Protective devices. There is a need for protective devices that can be worn or used by individuals disarming or locating mines in a mined area. Protective flyer's armor affords protection against fragments from antipersonnel, antitank mines, hand grenades, and pistol fire, but not against rifle fire at close range. This suit partially covers the chest, back, crotch, and groin of the wearer. Overshoes or boots worn over shoes may give some protection against antipersonnel mines for feet and legs. Unbreakable goggles and face pieces may provide some protection against explosive blast, dirt, and fragments. The US Marine Corps has a shoe pack that is reported to have been used successfully in Korea against antipersonnel mines. It is understood that trapped air between double soles of the shoe and felt inner soles provides a cushioning effect against mine blast.

(d) Manual clearance and removal of mines. Mine clearance is the location, and removal, or destruction of mines. The method of mine disposal is a command decision. Mines may be removed from the ground manually, either by hand or pulled out by wire or rope, or destroyed in place by explosives.

1. Hand removal. Hand removal is employed when mines must be removed silently or when undesirable destruction of nearby structures would result from detonation of the mine in place. The following sequence should be followed:

1. Probe to locate exact location of mine.

2. Uncover dirt from mine to identify type; remove earth from around mine and feel for wires and activation devices.

3. When all devices on top and sides of mines are neutralized, dig a hole to one side of mine. Then dig under mine and feel with fingers for any additional devices; neutralize any found. A small mirror often helps in this operation.

4. Carefully lift mine and move to a safe place for disposal.

2. Rope removal. Rope removal is safer and quicker than hand removal and in some instances is the proper method of disposal. When actuated mines are pulled and exploded, nearby mines may become sensitive as a result of the blast. Procedure for pulling mines by wire or rope is as follows:

1. Probe to locate mine.

2. Uncover top of mine.

3. Attach 50-yard rope or wire to mine or group of mines without moving or disturbing them.

4. Move all personnel from field to a known clear area. This prevents casualties should sympathetic detonation occur. Areas of protective cover from where ropes are to be pulled must be searched for antipersonnel mines.

5. Take cover and pull mines from holes.

6. If mines do not detonate, wait 30 seconds before moving up to mines. This prevents casualties from delay action fuses.

7. Check for additional mines, pull wires, and activation devices.

8. Carry mines to dumps for later disposal or reuse.

(2) Mechanical clearing. Many types of rollers, plows, dozers, flails and jet devices have been tested against pressure type anti-personnel and antitank mines but the weight and size of these devices are definite limitations.

(a) Roller. Currently the most effective method of eradicating mines by mechanical devices is the large roller (Rapid Roger) which consists of twenty-five parrallel disks approximately four feet in diameter, individually suspended, and enclosed in a frame which is attached to the front end of a tank. This roller can be used alone to breach a path 16 feet wide, or it can be used in conjunction with explosive clearing devices. It is effective against most contact type mine fuzes, and can be used in assault gapping because of its speed.

(b) Flails. This method employs heavy chain flails which remove 3 to 6 inches of soil and explodes the mines in place. The characteristics of this device limit its employment to roads and gently sloping terrain. Some versions of the flail actually displace or cut up mines and consequently they may be effective against all shallow-buried mines.

(c) Plows. The mine plow evacuator is a positive active clearing device for clearing all types of mines. Its forward action causes a cushion of earth to push up between the plow and the mine. It is slow moving and needs an enormous amount of pushing power. The plow is apparently capable of deeper eradication than any other currently available device.

(d) Jet clearing device. This system clears the mines by utilizing the scouring action of the jets. This device is capable of clearing a lane about 20 feet wide, and 100 to 300 yards long. Its positive action clears all types of mines and the equipment has reasonable maneuverability.

(e) Improvised methods. These are devices or methods to supplement standard approved methods or to be used when other methods are not available. The use of tractors, trucks, or tracked vehicles, or any vehicle that can be pushed through a mine field ahead of another vehicle of approximately the same track width may be valuable. If the vehicle can move under its own power it may be started in a low gear range, in the direction of the lane to be breached. A second or third vehicle may similarly be used until the far side is reached. If the vehicle has sufficient power, other equipment may be towed slightly offset to either side to get better coverage of the lane. If one of our tanks are struck a mine another vehicle could continue pushing the disabled vehicle through the mine field until the enemy side is reached.

(3) Explosive method. Explosive methods are used most advantageously when surprise and speed in the attack is essential, and when flails are so "loused up" with activated or probe-proof mines that

position. The rocket is fired, projecting the viper to its full length. It explodes on impact, making a path 90 percent clear of Schu-mines, 4 feet wide. Antitank mines are exploded directly under the viper body and other mines may be uncovered by the explosive blast.

2. The giant viper is 800 feet long and the explosive charge weighs 3200 pounds. It can be transported behind a tank in a special trailer. When it is projected the cluster of rockets tows the explosive through the air and the leading portion of the viper body lands about 1050 feet from the launching trailer. The near end of the viper is approximately 300 feet from the trailer. The viper explodes on impact and may clear 90 to 95 percent of all pressure type mines 12 feet on each side of the explosive. Tests of this device indicate that its reliability in clearance of vehicular lanes is questionable because of the "skip" effect of the linear charge.

(c) Improvised devices. There are devices that can be used to breach gaps when there is a limited supply of standard equipment. The use of detonating cord made up into bundles of 10 to 14 strands, 25 to 100 feet long is one method of improvised clearance. The rope is thrown or projected by rifle grenades or inert mortar rounds and detonated by electric or nonelectric blasting caps, thus breaching a path for attacking infantry. A grapnel hook attached to a rope or wire can be thrown across antipersonnel mine fields and drawn back by pulling the rope. The grapnel may catch trip wires and explode mines in its path.

(4) Floating and amphibious mines.

(a) Breaching floating or antiamphibious type mines may be accomplished much the same way as with conventional type mines. Floating mines may possible be exploded by weapons fire. After the mines have been stopped or are beached, they can be detonated by explosive charges.

(b) Breaching of mines placed between low and high side levels to oppose amphibious landings may be accomplished by normal methods during low tide. Amphibious snakes, depth charges, and charges placed by underwater demolition teams, may be used to detonate underwater mines. Immersion proof detectors assist in locating these mines. There is a possibility that hydraulic jets can be used to displace underwater mines.

5. CONCLUSIONS.

a. That present methods employed in mine field reconnaissance for the purpose of breaching are incomplete.

b. That present mine field breaching methods can be improved without providing new equipment.

6. RECOMMENDATIONS.

a. That contents of Appendix F be included in FM 5-32, May 1949.

b. That detailed characteristics of the various mine detecting and clearing devices be adequately covered in appropriate technical manuals.

APPENDIX

RECOMMENDATIONS FOR REVISION OF FM 5-32
MAY 1949, LAND MINE WARFARE

CHAPTER 3

MINE FIELD INSTALLATIONS

SECTION 1. MINE FIELD PLANNING AND RECONNAISSANCE

34. GENERAL

The primary requirement for any mine field is that it contribute to the effectiveness of the over-all tactical and strategic plan. This consideration makes mandatory the complete coordination with operational planning, ground reconnaissance must be performed before the details of the mine-field plan can be fixed.

35. PLANNING

a. Coordination

Once laid, a mine field restricts the freedom of maneuver of friendly as well as enemy forces. Mine fields and supporting weapons mutually affect one another, because where mine fields are strong, the requirement for supporting weapons is reduced, whereas weak mine fields must be protected by proportionately stronger supporting weapons. The mine-field plan must be fully coordinated with:

(1) Plans for the withdrawal of covering forces.

(2) Plans for the employment of combat or reconnaissance patrols.

(3) Plans for the establishment of outposts, listening posts, and observation posts.

(4) Plans for attack, counterattack, and retrograde movements.

(5) Plans for fire support by small arms, automatic, artillery, air, and atomic weapons.

(6) Plans for the employment of chemical agents.

(7) Plans for the relief of the installing unit in position, or by passage of lines.

(8) Plans for barriers or demolitions.

(9) Operational plans of adjacent and higher units.

(10) Over-all logistic support plan.

b. Type of mine field to be installed.

The selection of the type of mine field to be installed is primarily determined by the desired end result of the mine field in the over-all operational plan. Additional factors which must be considered include:

(1) Effectiveness required, based upon enemy capabilities.

(2) Logistic capabilities with respect to availability of numbers and types of mines, transportation, and means of installation.

c. Priorities of mine installation.

The mine-field plan must be designed to provide the greatest possible effectiveness at each stage of progressive completion of the entire plan. Priorities must, therefore, be established for completion of each portion of the mine-field plan which in itself has tactical value. If possible, the plan should provide for unrestricted mine-field improvement and reinforcement as time, material and means of installation become available.

d. Approval and dissemination of plan

Upon approval of the mine-field plan by the responsible commander, the plan should be disseminated to all interested tactical and logistics agencies. Wide dissemination of the mine-field plan is necessary so that the plan may be fully implemented, the progressive tactical effect anticipated, and unforeseen conflicts with operational or logistics plans resolved before the work of mine-field installation has proceeded too far for the correction of mistakes.

36. RECONNAISSANCE

Ground reconnaissance for locations of mine fields must be completed before the details of the mine-field plan can be fixed. Delay caused by mine-field reconnaissance may be avoided in many situations by conducting continuous mine field reconnaissance, just as new field artillery positions are reconnoitered during an advance. Reconnaissance should be conducted with full regard for established and anticipated operational plans, or logistics facts. In some instances, aerial photographs, and map and aerial reconnaissance should be made before actual ground reconnaissance is conducted. Ground reconnaissance should determine the actual location of the mine installation based upon the following factors:

a. The mission assigned to mines by operational plans.

b. The probable disposition of troops and supporting weapons.

e. The exploitation of the strength of natural or artificial obstacles.

f. The availability of mine materiel and installing means.

g. The necessity for friendly access routes through, or to points within the mine fields.

h. The desirability of friendly surveillance of mine fields and the undesirability of similar hostile observation.

i. The desirability to facilitate the progressive reinforcement and improvement of mine fields.

Section II. MINE FIELD PATTERNS AND DRILLS

37. PATTERN MINING.

a. Mine fields covered by small-arms fire should be laid to a pattern in belts when the area to be mined is extensive. Pattern laying by drill is more efficient, gives greater speed, and insures adequate coverage and proper density.

b. Standard patterns provide a means of uniform training and efficient field operations. The four row pattern for pressure actuated antitank mines (par. 41), the triangular pattern, and the pattern for pressure type antipersonnel mines (pars. 43 and 44) are considered standard. The antitank mine density of the four-row pattern is one mine per yard of mine-belt front.

38. NONSTANDARD PATTERN MINING.

a. Patterns other than those which are standard should be used under certain conditions. The factors which would favor a decision to lay mines in nonstandard patterns are:

(1) Limited availability of mines.

(2) Restricted areas (road blocks, defiles, gullies).

(3) Limited coverage by fire. Chapter II specifies in what type fields nonstandard patterns may be used.

b. The ingenuity of individuals, and their knowledge of the terrain and the enemy's tactics should be used to devise patterns for use where it is deemed inadvisable to use the standard patterns.

39. SCATTERED MINING.

a. Scattered mining is defined as the placement of individual mines without regard to the location of any other individual mine. The only exception is that one mine should not be laid within the sympathetic detonation range of another mine. This distance is four yards, for mines containing up to 25 pounds of explosive.

b. Scattered mining should be used when large areas not adequately covered by fire are to be interdicted. Careful analysis of terrain for likely avenues of approach and pattern to counter must be made for this method to be of real value. The minimum distance between mines is 4 yards; the maximum should rarely exceed 15 yards for interdiction of areas, but may be greatly extended in mule and mine mining.

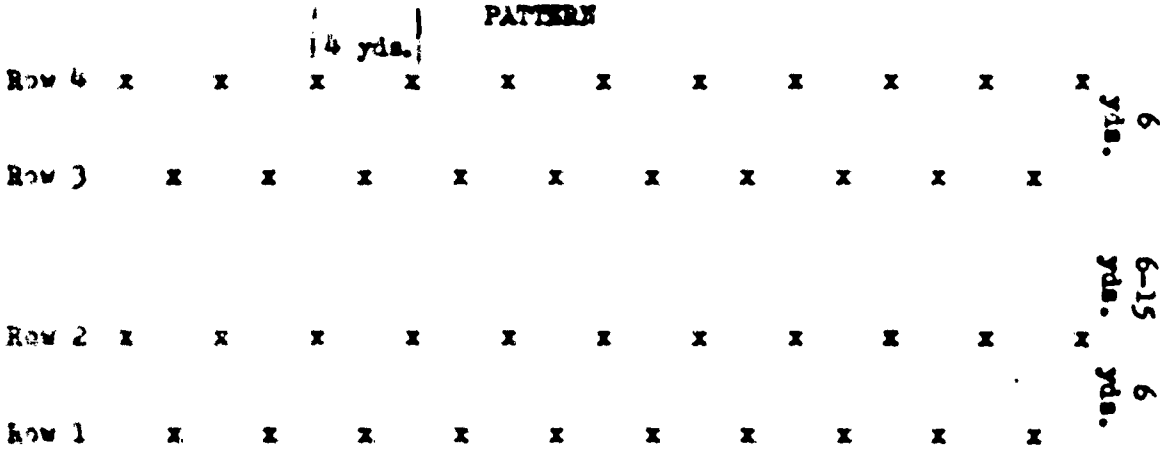
40. ROLLER MINING.

The most likely approach routes of armored vehicles not under attack will be the roadways. Retreating forces can extract high returns in damage and delay by using mines either scattered or in nonstandard patterns on these routes. Concrete roads must be breached by explosives or by tunnelling in from the side. Thin bituminous or gravel roads may be scarified by road graders or rooters. Chuckholes, edges or road craters, and railroad crossings are locations where mines may be installed without the aid of explosives or engineer equipment.

41. STANDARD PATTERN AND DRILL FOR PRESSURE ACTIVATED MINES.

a. Mines are laid in four rows. Mines in rows are 4 yards apart. The two rows on the enemy side of the field (rows 3 and 4) are 6 yards apart. Row 2 is laid at a variable distance of from 6 to 15 yards from row 3. Row 1 is 6 yards from row 2. Mines in rows 1 and 3 are offset from mines in rows 2 and 4.

PATTERN



b. When mines are laid by hand, distances should be paced. Care should be taken to avoid laying mines in rows in straight lines.

c. Drill for laying basic pattern with 30-pound mine follows:

Personnel	Equipment	Duties
Officer in Charge	Map, lensatic compass, notebook, mine-belt report	Reports to next higher headquarters the beginning of work, location of belt, number and types of mines to be laid, and estimated time of completion.

Personnel	Equipment	Duties
		Locates trace of mine belt, right boundary, determines distance between rows 2 and 3 and locates mine field safeguards (signs and fences). Designates locations of topographic markers and location of auxiliary markers. Collects all safety forks from squad leaders and has them buried beside right rear mine of each section. Makes location report of the mine field. Collects and verifies all records, verifies number of mines laid, turns in records, and reports completion of task to proper higher authority.
Platoon sergeant	Map, notebook, lensatic compass	Acts as second in command. Keeps information so he can replace officer if latter becomes a casualty. If mines are to be activated, designates their location to squad leaders. Supervises establishment of mine dumps.
First squad (siting party)	Long stakes or pickets 4 feet long and means of installing these in ground.	As directed by the officer in charge, NCO has a picket installed for row 1 and one for row 3 at the boundary of the belt. He then directs that stakes or pickets be placed every 100 yards, or when the

Personnel	Equipment	Duties
		officer in charge indicates that the belt changes direction. The pickets or stakes must be visible to a man standing at a distance of 100 yards. At night tracing tape should be installed from these guide markers, to the next guide marker. He also has installed metallic right rear reference marker within 15 yards of the right rear mine. A marker of this type is installed each 100 yards or when the belt changes direction.
Marking party (3 men)	Fencing materials, triangular signs, wirecutters, gloves and sledges.	Erect marking fences and signs as directed by officer in charge.
Recording party (1 NCO and 2 men)	Sketching equipment, including lensatic compass and metallic or steel tape, record forms map.	Fill out record forms as directed by officer in charge.
Second squad (laying and burying party)	Squad Leader: Notebook Layers: Mines Armers: Fuzes in sandbag Entire squad: Picks, shovels, and sandbags for burying mines	Carry mines from dump, and lay, arm, and bury all mines in rows 3 and 4 Detailed duties as follows: Squad leader: General supervision of squad: collects safety forks from armers on completion of each section; verifies number of mines laid and turns over safety forks to officer in charge.

Personnel	Equipment	Duties
		Assistant squad leader: Starting from picket indicating row 3, steps off 4 paces and indicates to layer to place mine near that point. Proceeds to second guide post indicating a mine location at every 4th pace.
		Layers: Each man gets 2 mines from the dump and reports directly to assistant squad leader. Within 3' of the location indicated by the assistant squad leader, he places one mine. He then takes 6 paces toward the enemy side of the field and two paces in the direction the belt is being laid and lays his second mine. He returns to the dump and repeats this procedure.
		Armers: Each armer is assigned one row. If mines are to be left on surface, he conceals them as best he can. He counts the number of fuzes in his sandbag before starting and after finishing a section.
		He checks the difference against the number of mines laid. Safety forms are turned over to the squad leader.

Personnel	Equipment	Duties
All		When all mines have been laid and armed, the entire squad buries the mines. (If anti-tank mines are to be activated, the mines designated by the platoon sergeant are left unburied) The mines may be laid and buried a section at a time, or the entire belt may be laid first and then buried. When antipersonnel mines are superimposed on the belt it is done after the unactivated mines have been buried.
Third squad (laying and burying party)	Same as for second squad	This squad is responsible for rows 1 and 2. Duties and procedures are the same as for the second squad. This squad does not start until the second squad has about 20 yards of their rows laid. This prevents having men in second squad walk through mines in rows 1 and 2 on way from dump. When the belt has been completely laid and recorded, all guide posts are removed. All debris resulting from operation must also be removed.

4. Drill for laying basic pattern with 20-pound mine follows:

Personnel	Equipment	Duties
Officer in Charge	Map, lensatic compass, notebook, mine-belt report	Reports to next higher headquarters the beginning of work, location, of belt, mines to be laid and estimated time of completion. Locates trace of mine belt, right boundary, determines distance between rows 2 and 3 and locates mine field safeguards (signs and fences). Designates locations of topographic markers and location of auxiliary markers. Collects all safety forks from squad leaders and has them buried beside right rear mine of each section. Makes location report of the mine field. Collects and verifies number of mines laid, turns in records, and reports completion of task to proper higher authority.
Platoon sergeant	Map, notebook, lensatic compass	Acts as second in command. Keeps information so he can replace officer if latter becomes a casualty. If mines are to be activated, designates their location to squad leaders. Supervises establishment of mine lanes.
First squad (siting party)	Long stakes or pickets 4 feet long, and means of installing these in ground	As directed by the officer in charge. SCO has a picket installed between rows 1 and 2 and one between rows 3 and 4

Personnel	Equipment	Duties
		at the bounary of the belt. He then directs that stakes or pickets be placed every 100 yards or when the officer in charge indicates a change in direction of the belt. The pickets or stakes must be visible to a man standing at a distance of 100 yards. At night tracing tape should be installed from these guide markers to the next guide marker He also has installed metallic right rear reference markers within 15 yards of the right rear mine. This type marker is installed each 100 yards or when the belt changes direction.
Marking party (3 men)	Fencing materials, triangular signs, wirecutters, gloves and sledges	Erect marking fences and signs as directed by officer in charge
Recording party (1 NCO and 2 men)	Sketching equipment, including lensatic compass and metallic or steel tape, record forms, map	Fill out record forms as directed by officer in charge.
Second squad (laying and burying squad)	Squad leader: Notebook Layers: Mines Armers: Fuses in sandbag Entire squad: Picks, shovels, and sandbags for burying mines.	Squad leader: General supervision of squad; collect safety forms from armers on completion of each section; verifies number of mines laid and turns over safety forms to officer in charge.

Personnel	Equipment	Duties
		Assistant squad leader: Starting from picket between rows 3 and 4 he has his layers form in two lines, 6 yards apart, behind him. He then steps off two paces and indicates left. The layers in the two lines move with him. The layers on the left places his mine when indicated. The assistand squad leader steps off two more paces and indicates right. The layer on his right places his mine. He repeats this process the length of the belt.
		Layers: Each man gets 3 mines from the dump and falls in on the two lines indicated by the assistand squad leader. Taking care to keep 6 yards from the man in the next row he places his mines as indicated by the assistant squad leader. He avoids placing his mines in a straight line. After he has laid his third mine he returns to the dump and repeats the procedure.
		Armers: Each armer is assigned one row. If mines are to be left on surface, he conceals them as best he can. He counts the number of fuses in his sandbag before starting and after finishing a section. He

Personnel	Equipment	Duties
		checks the difference against the number of mines laid. Safety forks are turned over to the squad leader. When all mines have been laid and armed, the entire squad buries mines. (If antitank mines are to be activated, the mines designated by the platoon sergeant are left unburied). The mines may be laid and buried a section at a time, or the entire belt may be laid first and then buried. When anti-personnel mines are superimposed on the belt it is done after the unactivated mines have been buried.
Third squad (laying and burying party)	Same as for second squad	This squad is responsible for rows 1 and 2. Duties and procedure are the same as for the second squad. This squad does not start until second squad has about 20 yards of their rows laid. This prevents having men in the second squad walk through mines in rows 1 and 2 on way to and from dump. When the belt has been completely laid and recorded, all guide markers are removed. All debris resulting from operation also must be removed.

42. ANTIPERSONNEL MINE BELTS. Antipersonnel mines may be installed in belts across enemy avenues of approach or to cover wide fronts against foot troops. Antipersonnel mines may be more effective than other antipersonnel obstacles because they are hard to see, and they produce casualties. To assure control and uniform coverage and to facilitate laying, patterns and drills are desirable. Because of the characteristics of individual antipersonnel mines and the use to which they may be put, two types of patterns are prescribed as standard. They are the triangular antipersonnel mine pattern and the pressure actuated antipersonnel mine pattern.

43. THE TRIANGULAR-PATTERN ANTIPERSONNEL MINE BELT

a. Antipersonnel mine cluster (fig 1). The antipersonnel mine cluster is the basic element of the triangular-pattern antipersonnel mine belt. A cluster consists of three trip-wire actuated mines placed at the vertices of a triangle that has one side roughly parallel to the front line and the opposite vertex toward the friendly side of the field. These mines are laid from and referenced to a reference line on the friendly side of the cluster. For recording purposes the mines are numbered in a counterclockwise direction. The mine at the friendly vertex of the triangle is No. 1, the mine at the right vertex is No. 2, and the mine at the left vertex is No. 3. Mine No. 1 is placed as the terrain dictates except that it is always placed at least 6 feet perpendicular from the reference line and toward the enemy side. Mine No. 2 is placed in direct prolongation of the extreme right trip-wire of mine No. 1 and exactly 6 feet from its end. Mine No. 3 is placed in direct prolongation of the extreme left trip-wire of mine No. 1 and exactly 6 feet from its end. In addition to the three mines operated by trip wires in each cluster, any number of mines actuated by pressure fuses may be added, but these are placed only in areas forward of the right and left trip wires of the No. 2 and No. 3 mines (fig 2). At no point should trip wires and pressure mines of one cluster be closer than 6 feet to trip wires of another cluster. Length, direction, and number of trip wires used with each mine are dictated by local terrain conditions. The maximum length used is 25 feet since that is the length of issue trip wires and about the casualty radius of the current bounding antipersonnel mines. At least two trip wires are used on the No. 1 mine. Normally two or more will be used on the other mines. Direction of trip wires depend on terrain, but NO TRIP WIRE IS POINTED TOWARD THE REFERENCE LINE AND NO TRIP WIRE CROSSES ANOTHER TRIP WIRE.

b. Combining clusters into a belt. A triangular pattern antipersonnel mine belt is a series of adjacent clusters which are referenced to a common reference line (fig 2). This reference line is marked on the ground with tracing tape at the time the belt is installed, and is laid in a zig-zag trace both to fit the terrain and

confuse the enemy as to the location of the belt. Clusters are located along the reference line to achieve complete coverage and the No. 1 mines of the clusters will normally be about 90 feet apart and seldom more than 110 feet apart.

g. Multiple belts. A single belt constitutes a mine field, but if more mines are available and there is time for their installation, it is desirable to secure greater depth and density by laying two or more belts in the same field (fig 3). Such belts are laid successively from the enemy side to the friendly side of the field and are numbered in this order for purposes of recording. Distance between belts is variable and depends upon depth of the field desired, number of belts to be laid, and terrain considerations. The rear reference tape of each belt is not removed until the mines and trip wires of the next belt have been laid (but not armed) and NO MINE OR TRIP WIRE OF ANY BELT IS PLACED CLOSER THAN 6 FEET TO THE REAR REFERENCE TAPE OF THE PRECEDING BELT.

PLATOON DRILL FOR LAYING A TRIANGULAR-PATTERN ANTIPERSONNEL MINE BELT

a. Organization of working parties. Below are suggested working parties and equipment for laying a mine belt.

Party	O	NCO	EM	Equipment
Officer in charge	1			
Siting and marking party		1	3	Compass, tracing tape, stakes, axes, nails, barbed wire, pickets, and mine field marking signs.
Three laying parties		1 1 1	9 9 9	Mines, fuses, pliers, picks, shovels, and sandbags.
Three recording parties		1 1 1	1 1 1	Sketching equipment, compasses, steel tape, record forms, and maps.

g. Duties of the officer in charge:

(1) Reports to next higher headquarters the beginning of work, location of belt, number and types of mines and estimated time of completion.

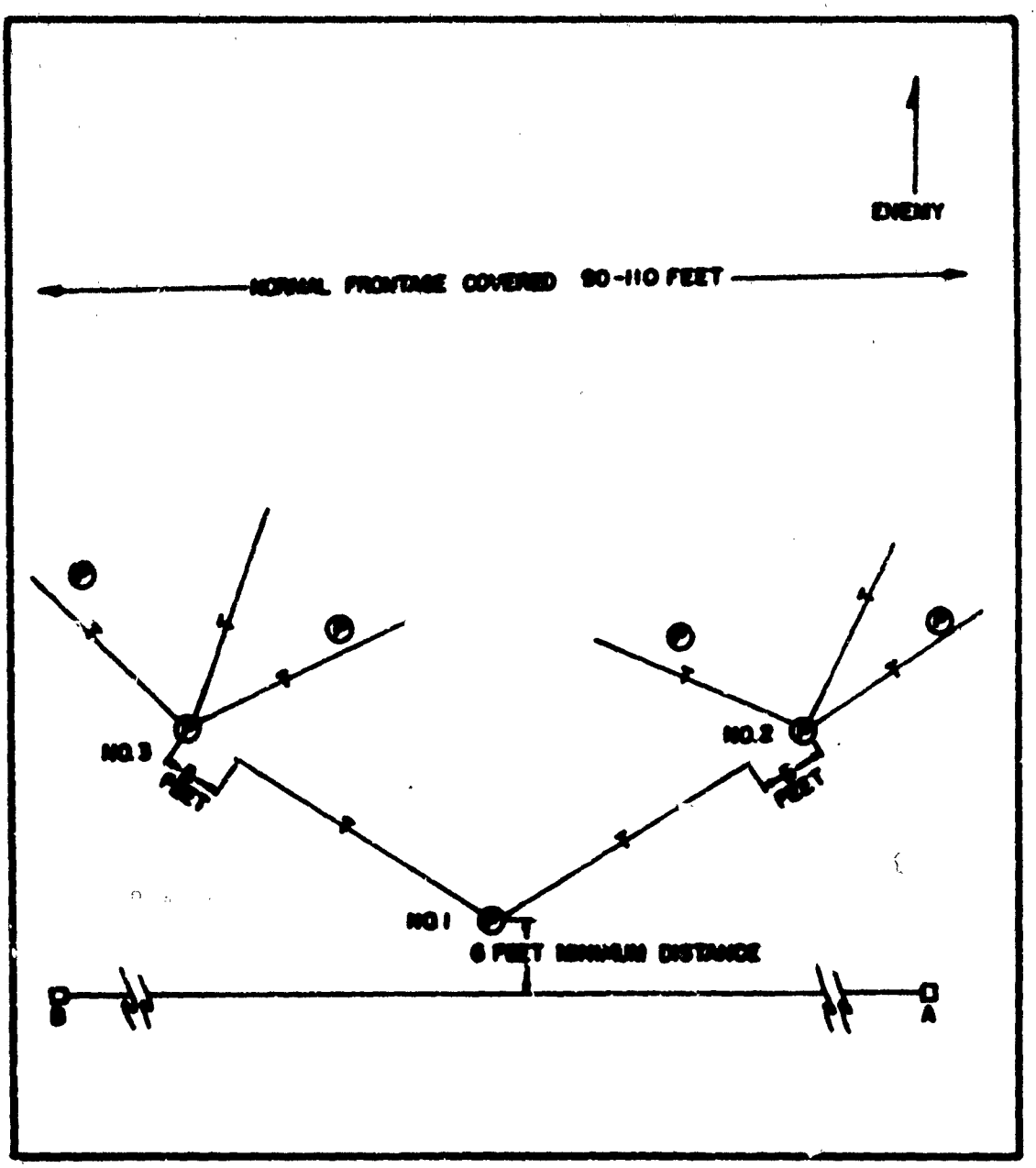


Figure 1. Antipersonnel mine cluster.

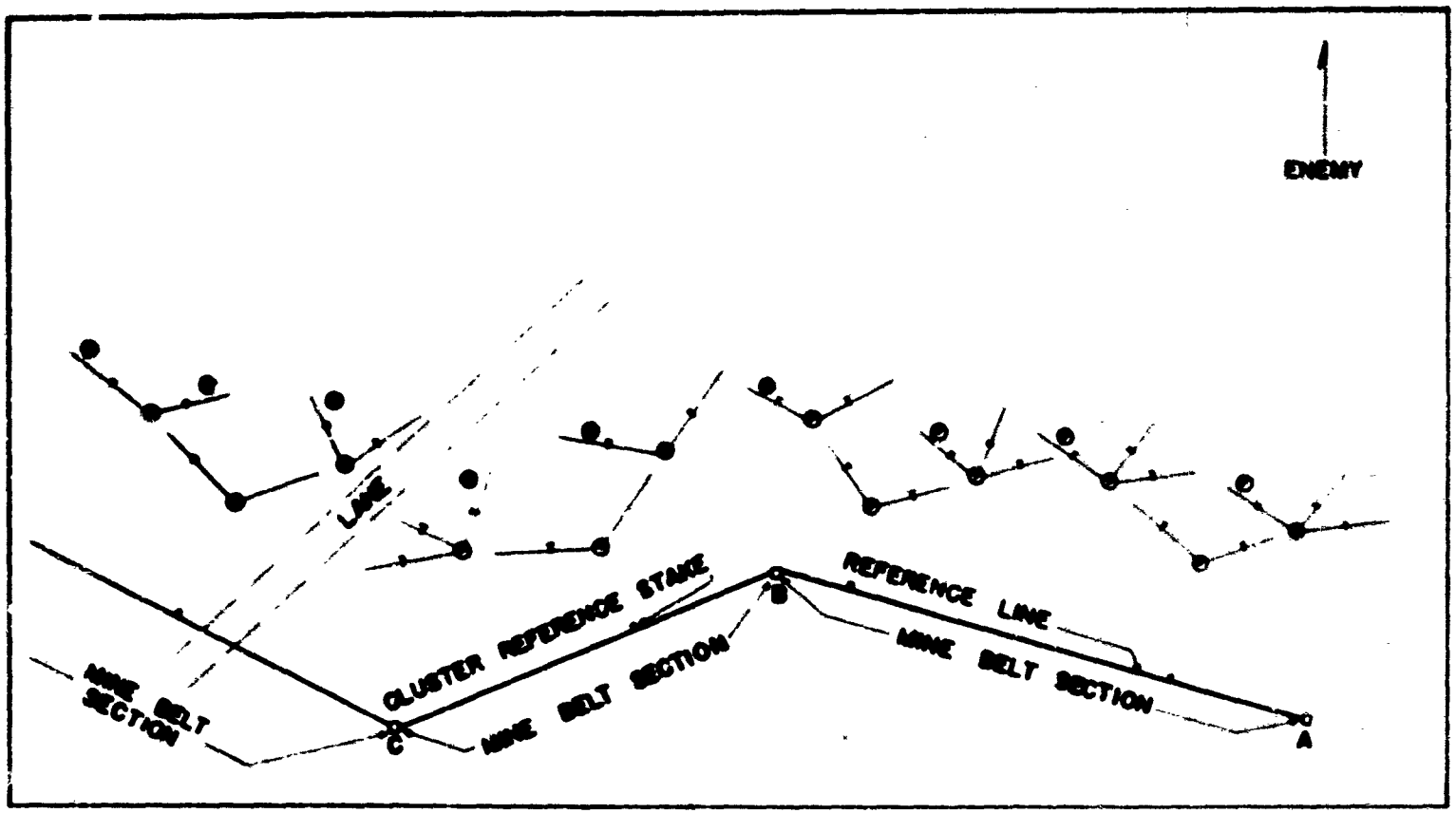


Figure 2. Triangular-pattern antipersonnel mine belt.

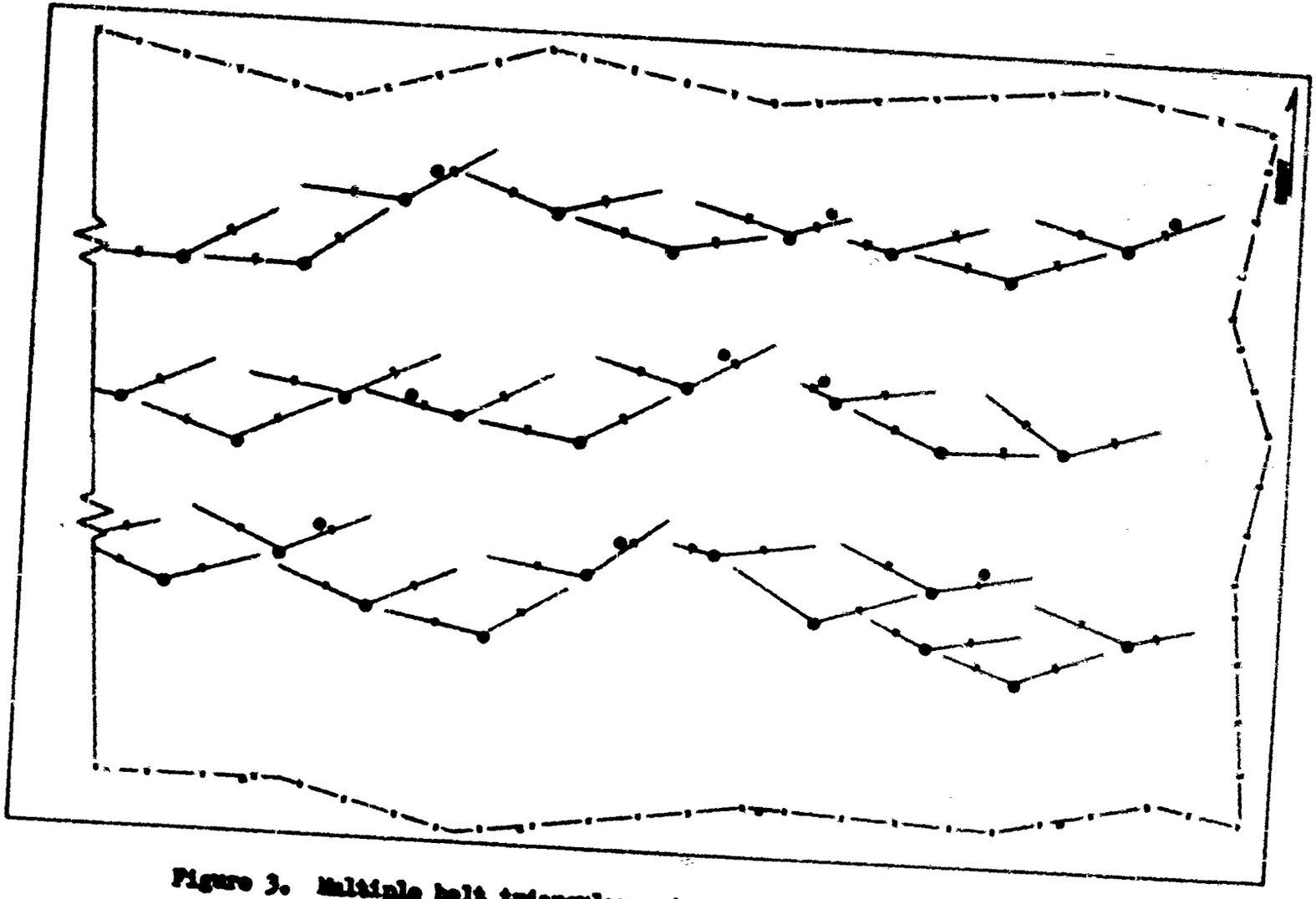


Figure 3. Multiple belt triangular-pattern antipersonnel mine field.

(2) Indicates exact trace of rear reference tape.

(3) Indicates location of safe lanes through field.

(4) Controls laying of entire field.

(5) Selects topographic marker and indicates location of any auxiliary markers.

(6) Collects detailed mine-cluster records and, with the assistance of the recording parties, prepares the mine belt records, and submits reports.

f. Duties of the siting and marking party. This party installs the reference line tape (fig 4), installs and marks safe lanes through the field, and fences the mine field (fig 5). Duties are as follows:

(1) The platoon sergeant in charge of party.

(a) Acts as second in command of the platoon.

(b) Assists the officer in siting reference tape and safe lanes.

(c) Controls squads in siting mine clusters and arming mines throughout the field.

(d) Checks erection of mine-field marking fences and safe-lane markers.

(2) The three enlisted men:

(a) Lay tracing tape along trace of reference line, and drive section reference stakes at each point where the reference line changes direction and at intermediate points as directed.

(b) Lay tape along both sides of any safe lanes that are to be left clear through the belt; erect mine field marking fence, signs, and lane markers; and drive all stakes flush and remove all tapes after marking fence is completed and all mines in the belt are laid and armed.

g. Duties of the three laying parties. Each party lays and arms three clusters at a time.

(1) The noncommissioned officer in charge:

(a) Indicates location of the No. 1 mine of each cluster, the direction and length of trip wires, and the location of any pressure mines to insure complete coverage of front.

(b) Has a stake or spike (mine-cluster reference marker) driven on reference line, opposite each No. 1 mine, to facilitate later location of the cluster.

(c) Supervises work of party.

(d) Directs the procedure in arming each mine.

(e) Checks the accuracy of cluster sketches prepared by the recording party.

(f) Collects and counts all safety pins and clips and has them buried 1 foot to the rear of the right hand section reference stake.

(2) The nine mine layers of each party are divided into three details of three men each:

(a) The first man in each detail places No. 1 mine at spot indicated by the noncommissioned officer and lays out trip wires (fig 6). He anchors the far end and ties the near end to the mine but not to the pull ring of the fuse.

(b) The second and third men of each detail site No. 2 and No. 3 mines in prolongation of the extreme right and left trip wires of the No. 1 mine and exactly 6 feet from the trip wire ends. Then they lay out and anchor the trip wires of their mines but do not fasten them to the pull rings of the fuses.

(c) The second and third men also place any pressure-operated mines that are to be used with the cluster, as directed by the noncommissioned officer.

(d) All men fuse and bury their mines and attach all trip wires to pull rings (fig 7). Mines and trip wires are then camouflaged. In some cases mines may be laid directly on the ground.

(e) As soon as all mines are buried and camouflaged and the cluster record if required, is completed and checked, the mines are progressively armed on command of the noncommissioned officer. The number 2 and 3 men first arm their pressure mines, starting with those farthest from the trip wires. They then arm the No. 2 and No. 3 mines and leave the field by walking to the No. 1 mine along its trip wires

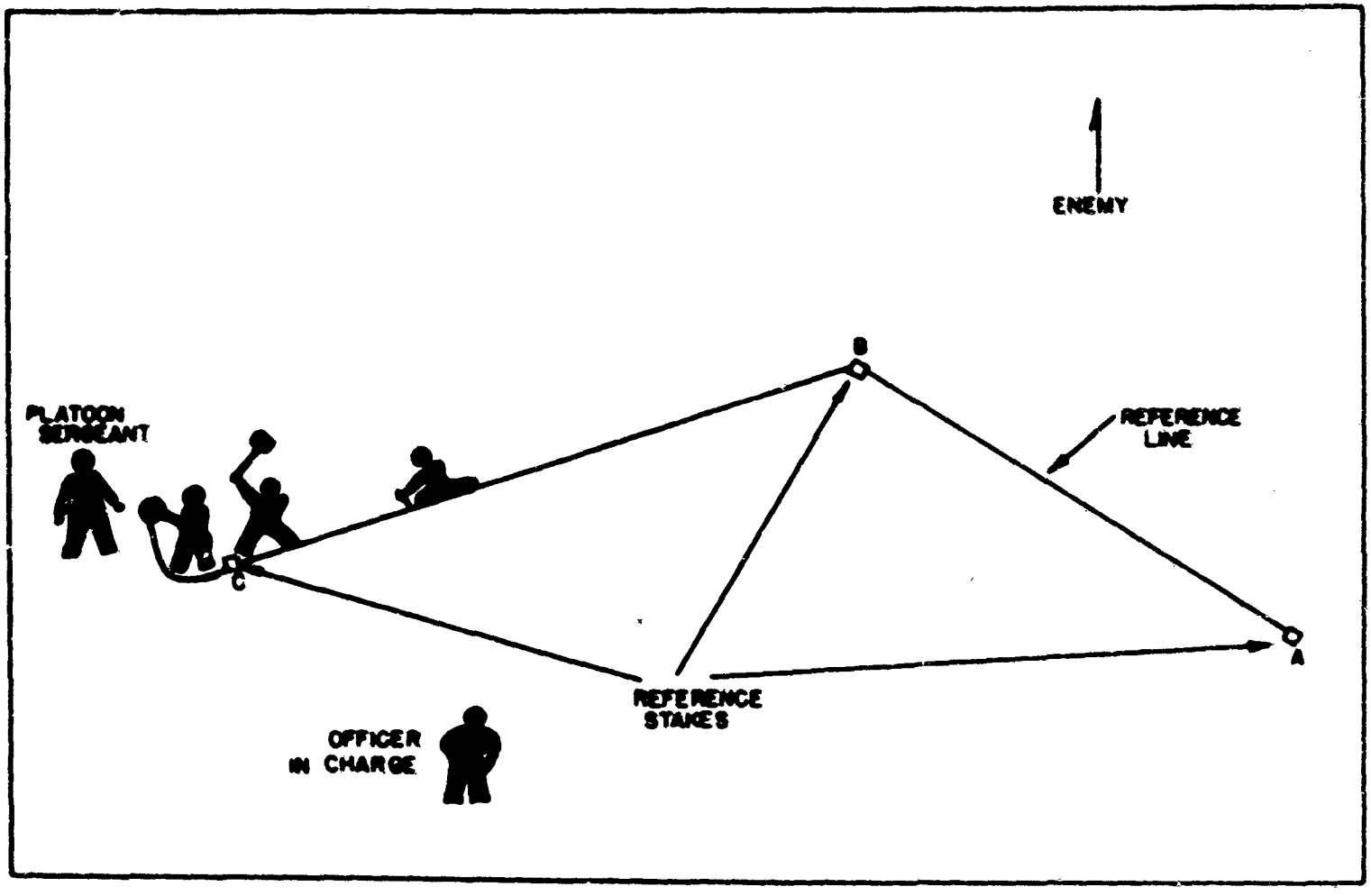


Figure 4. Installing reference-line tape.

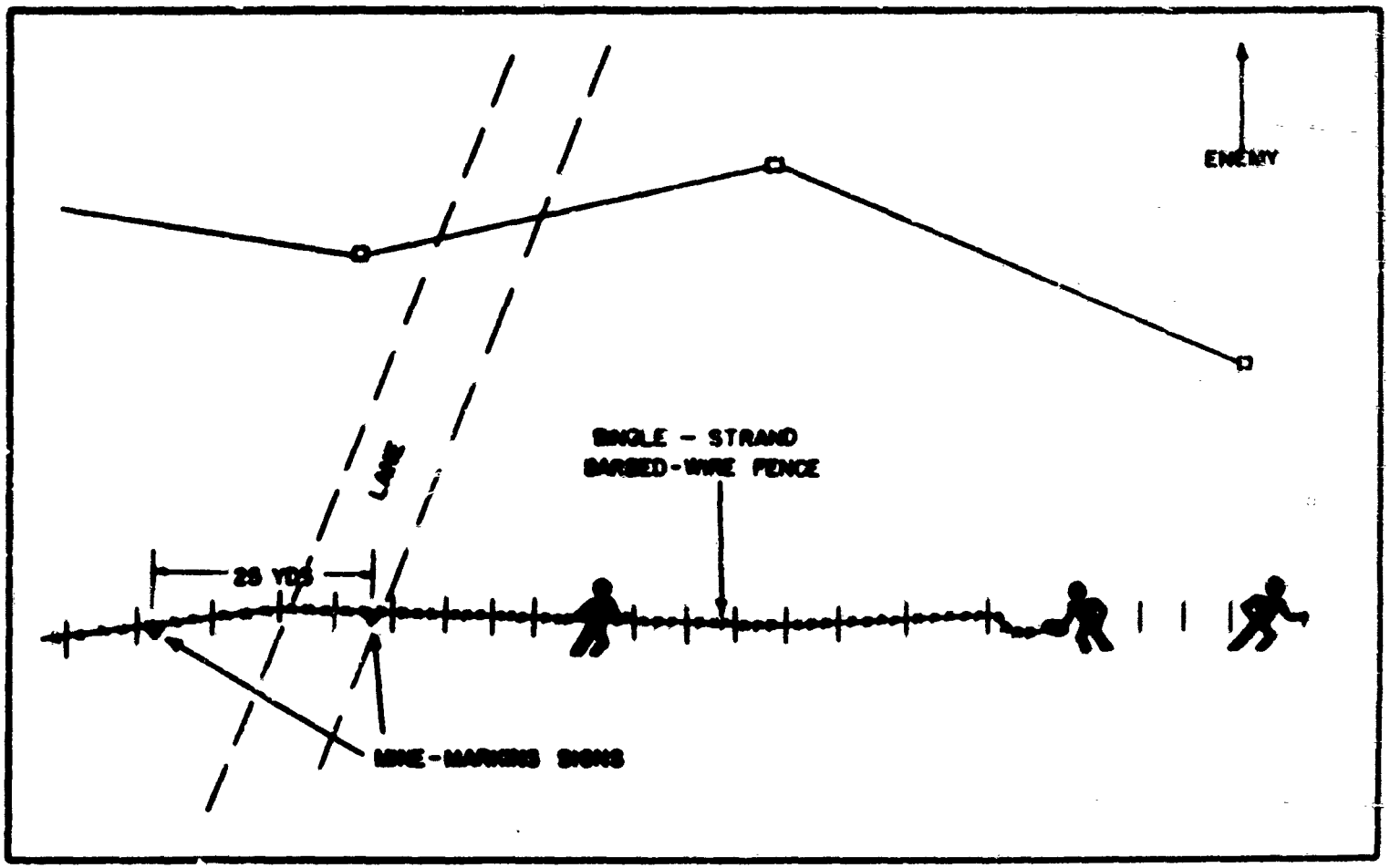


Figure 6. Fencing the mine field.

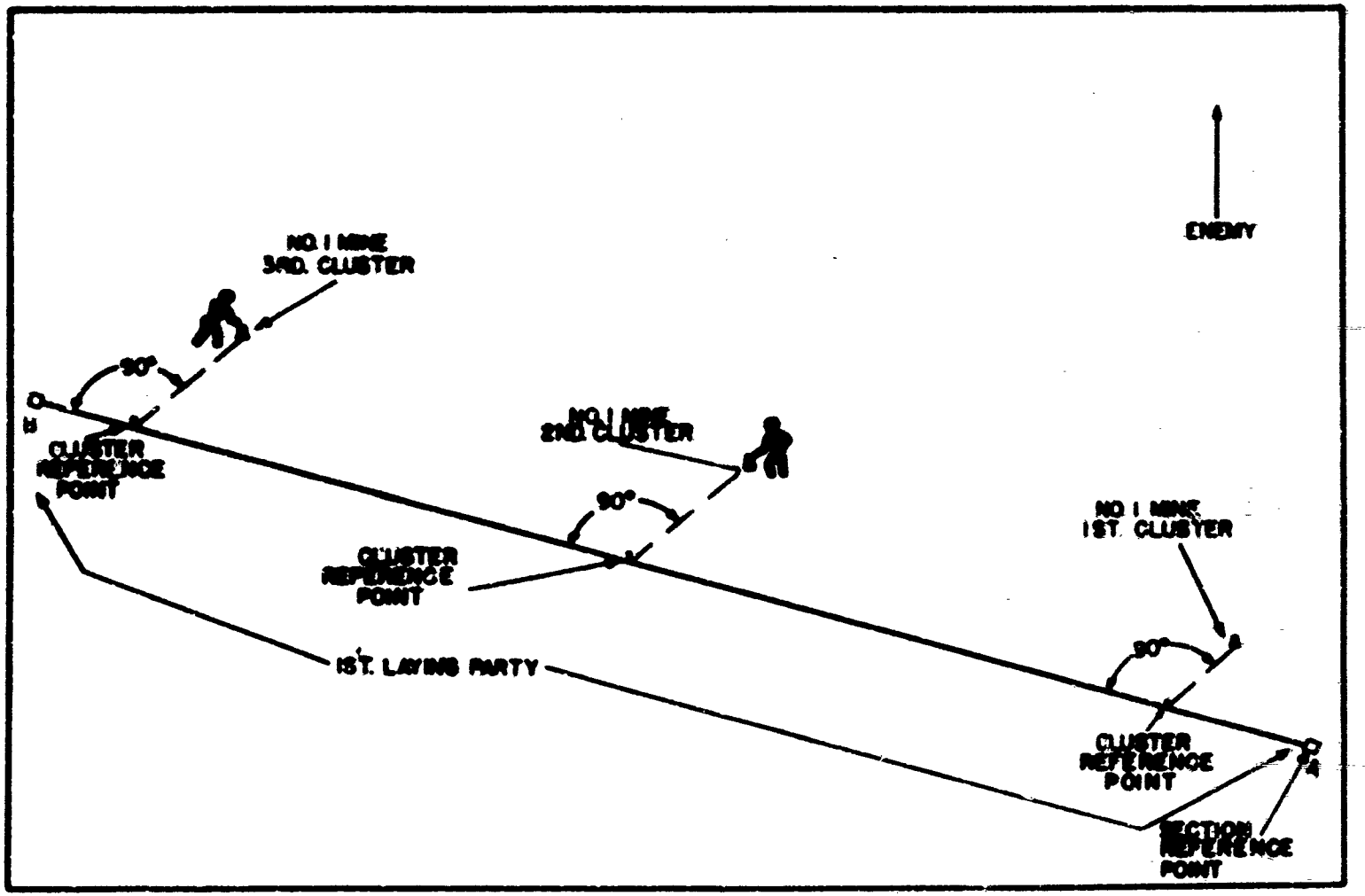


Figure 6. Placing No. 1 mine in each cluster.

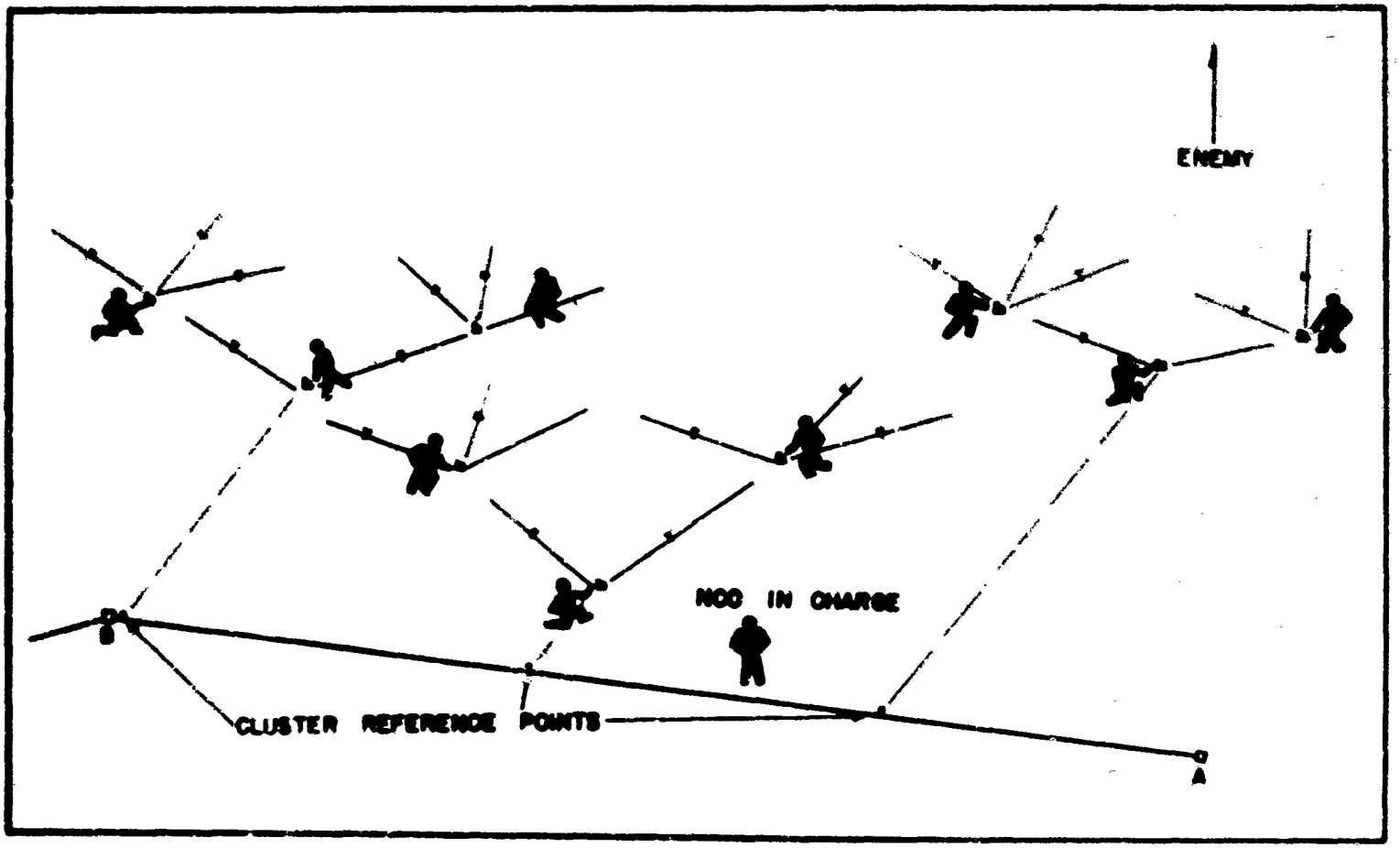


Figure 7. Laying party installing mines in triangular pattern.

and from it directly to the reference tape where they turn their safety pins and clips over to the noncommissioned officer. The number 1 men then arm their mines, return to the reference tape, and turn safety pins over to the noncommissioned officer. All men lie prone while mines are being armed.

(3) As soon as the safety pins and clips have been buried 1 foot to the rear of the right-hand reference stake of the section, each party leaves the belt, walking along the reference tape, and reports to the platoon sergeant for assignment to another three clusters.

h. Duties of the three recording parties. The recording parties:

(1) Report to the officer in charge and aid him in preparing the location report of mine field and the Detailed records.

(2) Report to the laying parties and prepare a record for each mine cluster (fig 8) if required. After these records are checked by the noncommissioned officers in charge of the laying details, they are turned over to the officer in charge for signature, numbering, and entry into the mine field records.

44. THE PRESSURE ACTUATED ANTIPERSONNEL MINE BELT.

a. The pattern for a pressure antipersonnel mine belt is used when the belt consists mainly of pressure type antipersonnel mines. The pattern is designed so that a belt can be safely and quickly laid, simply recorded, and safely removed. The pattern is laid to a reference line and can form sections of variable length to fit the terrain.

b. The pressure actuated antipersonnel mine pattern section. This antipersonnel mine section consists primarily of pressure type antipersonnel mines laid on the enemy side of a reference line along lines perpendicular to the reference line at 6-foot intervals. One or more mines may be placed along each perpendicular line at various intervals to obtain desired density. The distance of the first mine from the reference line varies, but is never less than 6 feet and usually not more than 30 feet. The same number of mines is normally placed along each perpendicular line to maintain a uniform section density, but the density of a section may be increased where the belt passes through the most likely area of anticipated enemy penetration. Trip wired mines should be used on the farther most mine in every fourth or fifth perpendicular to serve as a warning measure against enemy penetration.

c. Combining sections into a belt. Belts are made up of sections using the same reference line and having the same density except as noted in b above. In laying a belt it is necessary to lay a right-

hand boundary tape for each section so mines in one section will not interfere with mines in the adjacent section. Mines in a section are never laid across the boundary tapes on either end or within 3 feet of them.

d. Multiple belts. (Fig 9). Procedure is the same as in laying the triangular-pattern belts.

e. Platoon drill for laying pressure-started antipersonnel mine belt.

(1) The organization of working parties is the same as for laying the triangular-pattern antipersonnel mine belt (par 43).

(2) Duties of the officer in charge are the same as in laying the triangular-pattern antipersonnel mine belt (par 43).

(3) Duties of the siting and marking party. This party lays the reference tape and the right-hand boundary tapes, marks safe lanes through the field, and installs field fence and markers (fig 5).

(a) The platoon sergeant in charge of party:

1. Acts as second in command for the platoon.

2. Assists officer in siting the reference line and safe lanes.

3. Controls laying parties.

4. Locates and checks the erection of mine field marking fences and safe-lane markers.

(b) The three enlisted men:

1. Lay tape along trace of reference line and place section reference stakes at right-hand end of each section and at intermediate points as directed.

2. Place a right-hand boundary tape 50 feet long, at the right hand reference stake of each section and perpendicular to the section reference line.

3. Lay tape along both sides of any safe lanes.

4. Erect mine field marking fences, signs, and lane markers.

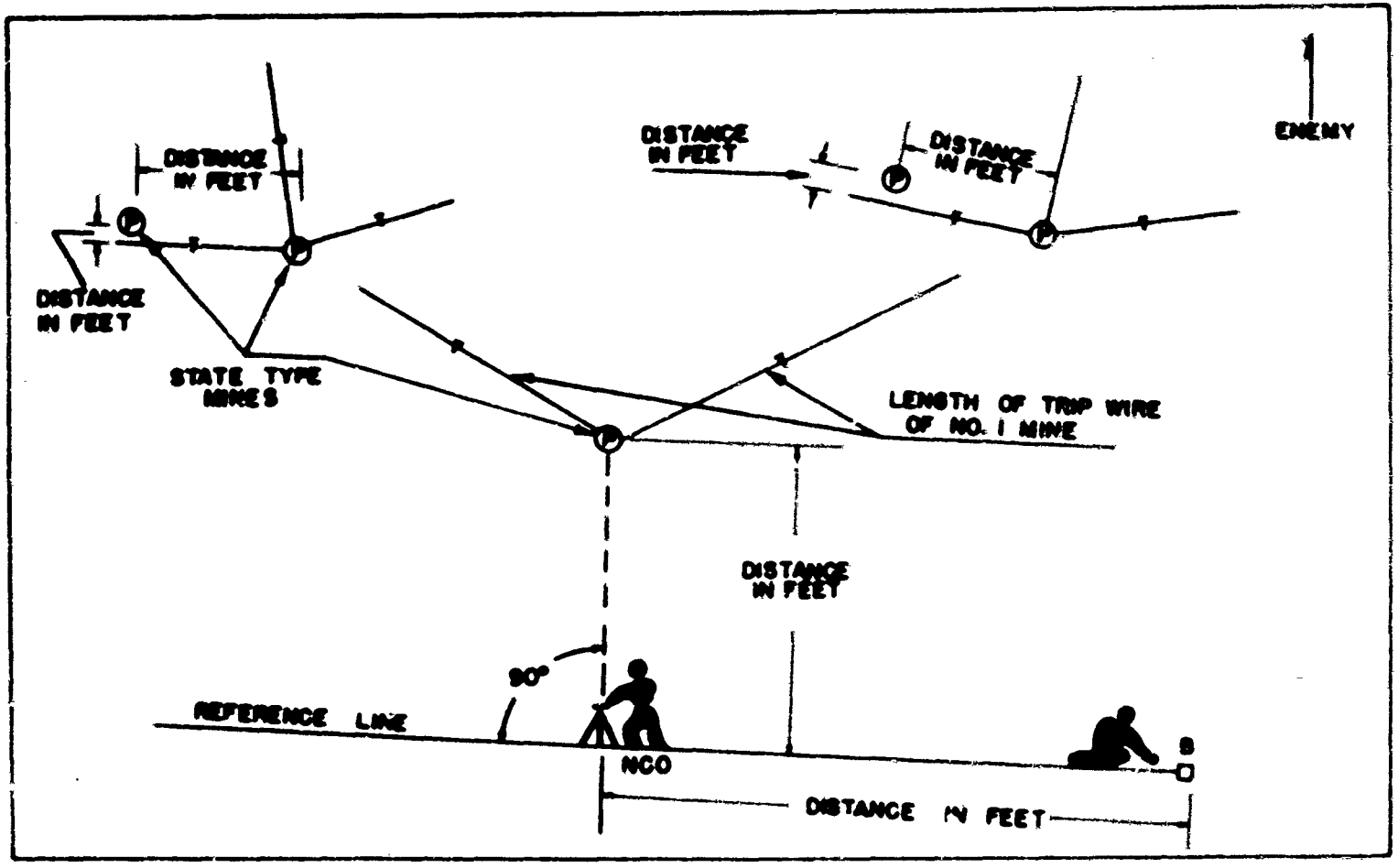


Figure 8. Recording party preparing records of mine cluster.

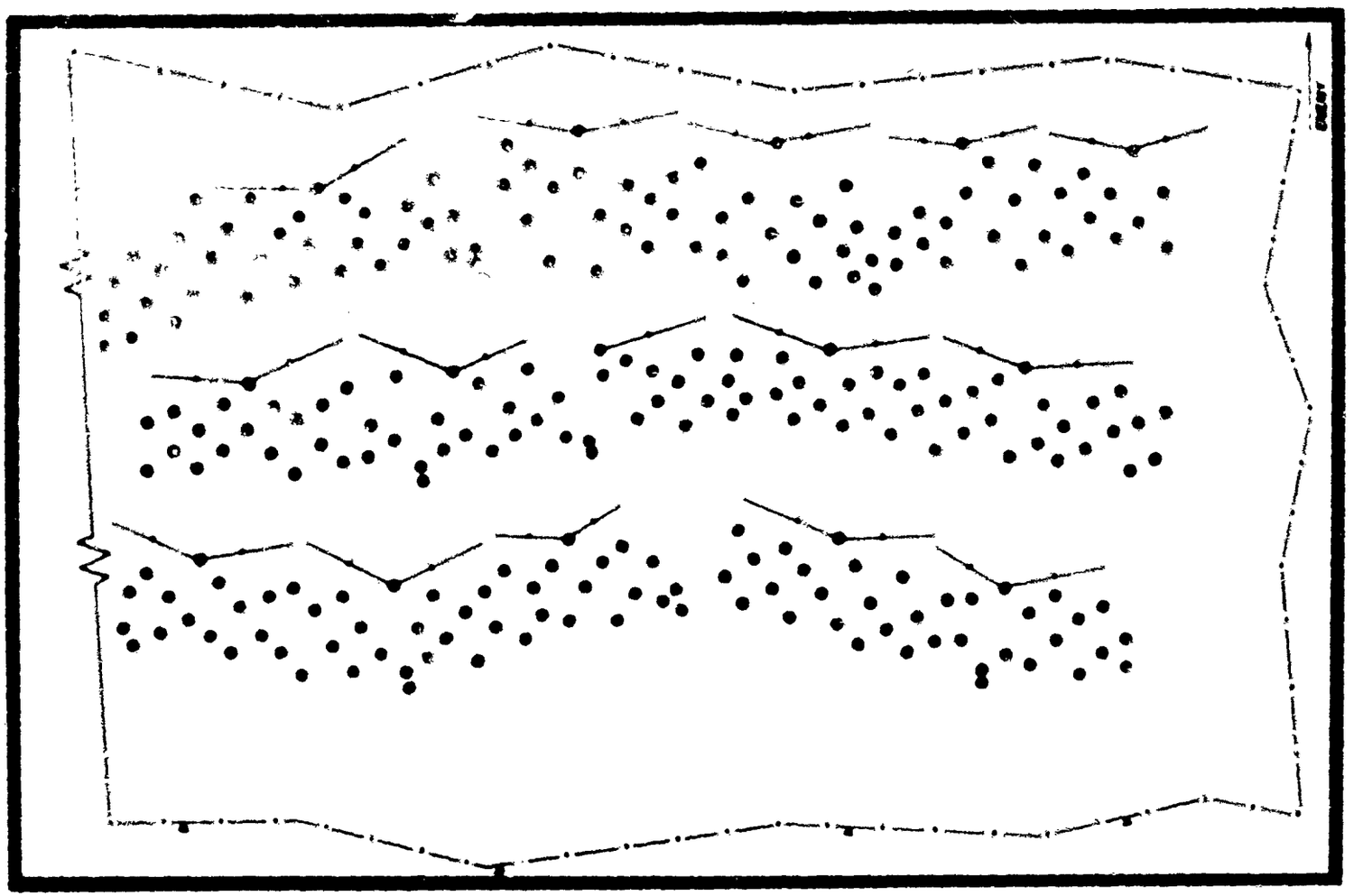


Figure 9. Multiple belt pressure-pattern antipersonnel mine field.

5. Drive all reference stakes flush and remove all tapes after the marking fence is completed, the belt is laid, and all mines in the belt are armed.

f. Duties of the three laying parties. Each 9-man laying party lays the mines in one section of a belt, or in part of a section, as ordered by the officer in charge.

(1) The noncommissioned officer in charge of each party:

(a) Has stakes or spikes driven along the reference line at 6-foot intervals, starting at the point where his party is to lay its first mine and working from right to left (fig. 10).

(b) Indicates the location of each mine along a line perpendicular to the reference line at each of these stakes.

(c) Supervises the work of the nine enlisted men.

(d) Checks the accuracy of the detailed mine-section record before the mines are armed.

(e) Directs arming procedure of each mine.

(f) Collects and counts safety pins and clips and has them buried 1 foot to the rear of each right hand section reference stake.

(2) The nine enlisted men of each laying party each take one or more mines, but always the same number, and:

(a) Place them on perpendiculars to the reference tape at distances from the mine reference stake as indicated by the noncommissioned officer in charge. MINES OF ONE SECTION ARE NEVER PLACED ACROSS THE RIGHT-HAND BOUNDARY TAPE OF THE NEXT SECTION NOR CLOSER THAN 3 FEET FROM SECTION-BOUNDARY TAPES.

(b) Lay out any trip wires used and anchor them. Trip wires are used on only those mines that are farthest from the reference tape. They are placed on at least every ninth such mine so that the frontage of the mines being laid is covered by trip wires. Trip wires never point toward the reference tape.

(c) Bury and camouflage their mines and attach any trip wires to pull rings. In some cases mines may be laid directly on ground. In addition, the number 9 man places markers on line with his mines and 6 feet to their left if any perpendiculars remain to be laid in the section.

(d) Arm their mines on orders of the noncommissioned officer in charge. Mines are armed progressively, the mines farthest from the reference tape being armed first.

(e) As soon as their mines are armed, return to the mine-reference stakes along perpendiculars to the tape and hand safety pins and clips over to noncommissioned officer in charge of party.

(3) The noncommissioned officer and his nine men repeat the above process with nine mine-reference stakes each time, until all the mines in their assigned section have been laid and armed. When the section is completed except for the last nine in the section being armed, the right-hand boundary tape of the next section is removed. Upon completion of a section, the party leaves the field along the reference tape and reports to the platoon sergeant for assignment to another section.

c. Duties of the three recording parties: Each recording party, composed of one noncommissioned officer and one enlisted man:

(1) Reports to the officer in charge to aid in preparing the location report of mine field and the required detailed records.

(2) Upon completion of this work, recording parties report to laying details to make a detailed section record for each section of the mine field if this is required. The parties turn their records over to the officer in charge for numbering, signature, and inclusion in the mine-field report.

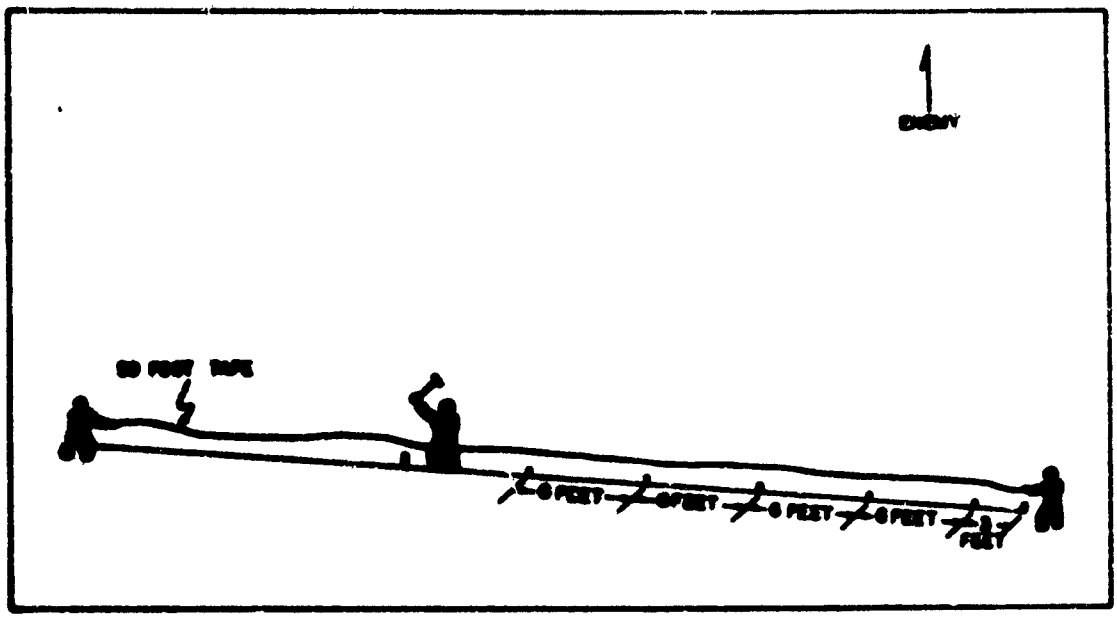


Figure 20. Driving mine-reference stakes along reference line for pressure pattern.

SECTION III. MARKING, REPORTING, AND RECORDING

45. MINE FIELD RECORDING AND REPORTING.

a. The use of records and reports.

(1) All headquarters will keep special situation maps on which all essential information concerning friendly and enemy mine fields is graphically entered. This information is used to inform commanders, unit staffs, and troops in the mined areas. It is important, therefore, that newly installed mine fields be recorded and the records forwarded immediately to the proper headquarters. The operations officer should be the custodian of these records. All headquarters will keep a record of the number of mines issued to each unit, for periodic comparison with the records of mines installed.

(2) The detailed mine-field record is used primarily to facilitate the planning of tactical operations, gapping for passage of our attacking troops, changing gaps for friendly patrols, transfer of responsibility for defense of a sector, and removal of the mines when required.

(3) Enough local records are kept by installing units to facilitate transfer of responsibility.

b. Responsibility for recording and reporting.

(1) The headquarters authorizing the installation of a mine field is responsible that the necessary records and reports are made and forwarded to all interested headquarters.

(2) The officer in charge of installing the mine field is responsible for recording and reporting to the next higher headquarters all of the information required. He is also responsible for notifying adjacent units as soon as he starts the installation.

c. Information required in records and reports.

(1) The commander authorizing the installation of a mine field must decide the degree of detail of the mine field report.

(2) The degree of detailed recording required will be based on the following considerations:

(a) Existing policy of the senior commander.

(b) Future plans of the commander.

(c) Type of installation.

(d) Necessity of moving patrols through the installation.

(e) Permanency of the installation.

5. Types of records and reports.

(1) Dissemination of the mine-field plan when prepared.

(2) Preliminary mine-field report.

(3) Location report.

(4) Detailed record of mine belts

(5) Detailed record of mine-field lanes.

(6) Detailed record of each mine section.

6. Alterations of mine fields or removal of mines.

(1) A new report using standard forms, marked "Revised, must be made when the mine field is altered. This report must include the complete revised information as required by the authorising headquarters.

(2) The unit clearing a field will forward a removal report which will include the units retained copy of the original mine field report, and a report of the date and time of removal and the number and types of mines removed. Discrepancies between the original and the removal reports must be explained.

46. MARKING FIELDS AND LANES.

a. Methods of marking.

(1) General. To avoid casualties to our own troops, mine fields must be clearly marked. Marking must not reveal the extent or arrangement of the field.

(2) Marking fences. Marking fences are always completed, even if the mine field is not finished. Fencing is usually placed as the field is installed. Fences must be strong so that they will not collapse and leave the field unmarked. Breaks should be repaired immediately by the unit responsible for maintenance of the field. Fence posts should be 10 to 15 yards apart.

(3) Forward mine fields. Forward fields are fully fenced-in with a one-strand barbed-wire fence about 18 inches above the ground. The fence on the friendly side is marked by standard triangular markers attached to the wire at approximately 25-yard intervals (fig 36).

(4) Rear mine fields. A rear-area mine field must be fully fenced-in with one-strand barbed-wire fence. Standard triangular markers are attached to the wire at 25-yard intervals.

b. Marking safe lanes. Lanes and paths must be provided to permit passage of vehicles and troops through mine fields. The method of marking safe lanes through friendly mine fields is also used for marking safe lanes through enemy mine fields. When a mine field is breached on a road, standard mine-road clearance signs are used to mark safe lanes.

(1) In defense. Lanes through friendly mine fields must not be marked in any way that hinders their concealment or be in excess of the needs of our troops. Carefully placed low wire, or luminous buttons may be used to mark paths for friendly patrols. Paths or lanes should be well-guarded and altered frequently to prevent their detection and use by the enemy. Enough mines must be left near each lane to close it in case of enemy attack. A guard must be on each lane or path to guide friendly troops and to close the gaps when necessary.

(2) In attack or advance.

(a) During an attack or advance through friendly mine fields, where existing roads cannot be used, lanes are marked the same way as lanes through an enemy mine field. When a mine is located during clearing or breaching operations, its location is indicated by a standard or improvised mine marker (fig 37). Detector personnel place the mine markers to indicate to the mine lifters the location of the mines to be removed.

(Figure 37. Individual mine marker)

(b) Standard lane markers are placed at 25-yard intervals on each side of the lane with the white pointed part of the marker pointed toward the lane. Markers are supported 5 feet above the ground by fastening them securely to long pickets or posts. A two-strand barbed-wire fence connects the posts as an additional safeguard. Night marking of lanes consists of placing green and yellow lights on each marker. The green light is placed on the white portion and the yellow light on the red portion of the lane markers. On each of the markers at the entrance and exit of the lane a third light is added centrally between the two lights just described. At the entrance, the extra light is yellow; at the exit, it is green. See paragraph 63b.

(9) When mines are cleared from existing roads in the advance, road clearance signs similar to that shown in figure 38 are placed on each side of the road at intervals of 200 to 500 yards. Signs reading "Roadway swept for mines" may be used when only hasty mine clearance has been done (par 63).

(Figure 38. Examples of standard types of road-clearance signs.)

(3) Lanes through rear-area mine fields. Vehicle lanes through rear-area mine fields may be located along roads and trails to prevent obvious curves or deviations which would indicate a mine field or other obstacle. Also, measures are taken to prevent forming a network of tracks converging at the entrance to the lane. Lanes must be conspicuously marked and warning signs used plentifully. The standard lane-marking method is used.

c. Withdrawal. During a withdrawal, the lanes through rear-area mine fields must be closed as soon as all personnel have passed. The defense plan must be clearly understood by the unit responsible for closing the lanes. Sufficient warning must be given the unit responsible for closing lanes so that the work can be done quickly and effectively.

Note: Lable on fig 37 should read, Painted white must be neatable.

47. RECORDING A MINE FIELD.

a. General. Mine fields are numbered in sequence of installation by each unit. The first installation would be number 1, the second mine field installed by that unit would be number 2, and so on. The belts within a mine field are numbered from the friendly side. The sections within a mine belt are lettered from right to left. Distances on all records and reports are always shown in yards, except the distances on the detailed record of each mine section which are shown in feet.

b. Preliminary report. Commanders authorizing an installation will notify higher headquarters of the plan before actual installation is begun. As soon as the officer in charge of installing a mine field has organized and started the work, he sends the following information to his next higher headquarters:

(1) Location and extent of the field.

(2) Estimated time of completion.

(3) Type of mines to be installed.

Note: This may be done by telephone, coded radio message, or messenger.

Figure 36, FM 5-32, May 1949, has been changed as follows:

(Change 1, July 1950)

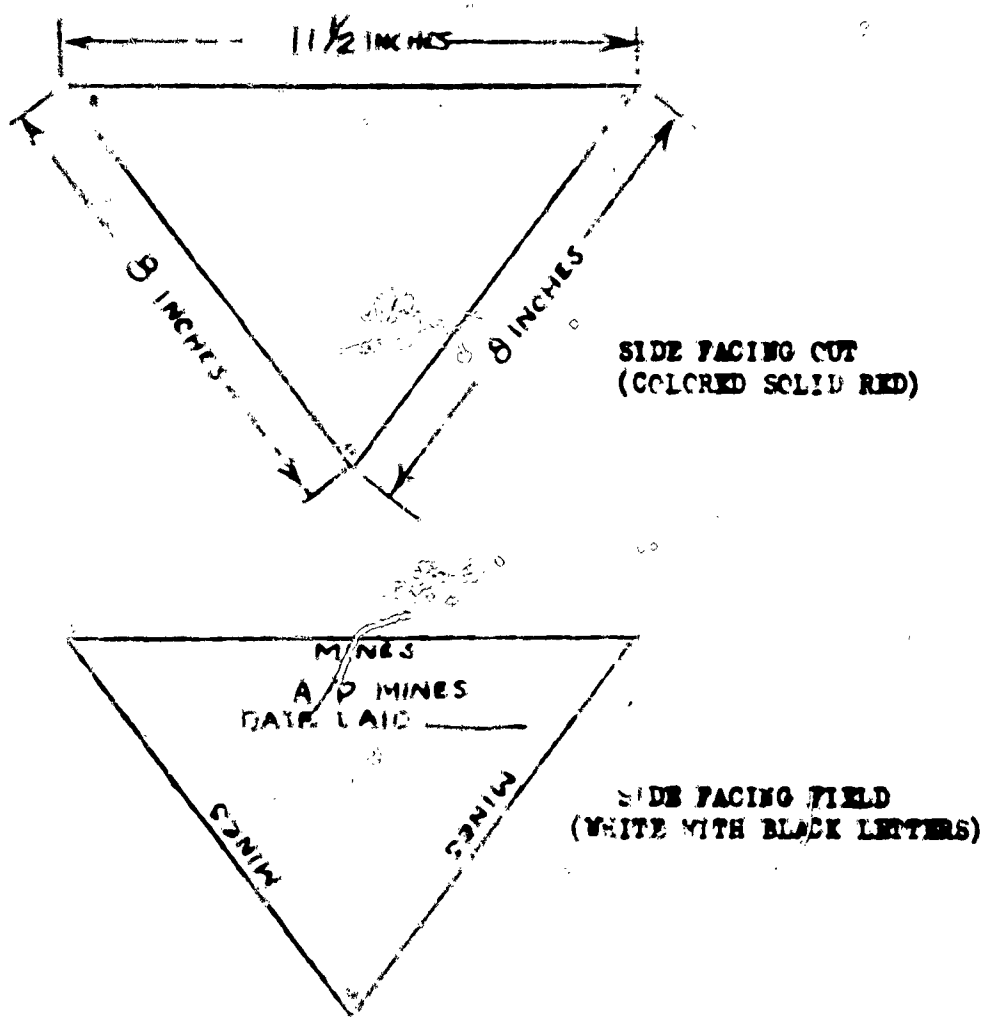


Figure . Minefield marker signs.

c. Location report of mine field. The location report contains the minimum information required about about an area that has been mined. The officer in charge of the installation supervises the preparation of the report. Space is provided on the form to record the location of two topographic markers, if available, assist to the location of the mined area. Reference to at least one topographic marker must be given. The distance and azimuth from the topographic markers to the nearest danger area are recorded in the spaces provided. The sketch of the mined area must be made on the back of the location report and must include: topographic markers, auxiliary marker if used, location of the mined area, approximate dimensions of the field, general location of the boundary marking, magnetic north, and direction of the enemy (fig 47). The completed location report is forwarded to the next higher headquarters. This headquarters must then distribute the information to all units concerned.

d. Detailed record of mine belts. This is a detailed record of each section of the belts in the mine field. The description of the mine field on this report will include: number of belts, pattern used, and the use of scattered mines, if any All data must be entered on the form: If an item on the record does not apply on appropriate notation is made. Provisions are made on the form to show any authorized scattering of mines between belts. The sketch made on the back of the report must include: accurate location of topographic and auxiliary markers, and their relation to each belt; sections of each belt, showing their length and azimuth; magnetic north; and direction of theenemy (fig 48).

e. Detailed record of mine-field lanes. This is a detailed record of the lanes in the mine field, the record will locate the topographic marker by description and coordinates; the azimuth and distance from the topographic marker to the friendly entrance to each lane; the azimuth, length width of each lane, and indicate how the lane is marked. The provisions for closing the lanes must be entered on this record. A sketch on the back of the record must show the location of the topographic markers, lanes, magnetic north, and direction of the enemy (fig 49).

f. Detailed record of each mine section. This a record of the individual antipersonnel and activated mines, and will require one sheet for each section of the mine field where this detailed record is required (fig 50). A sketch of the section must be made to include: right section stake; trace of first row; antipersonnel and activated mines by number and location; magnetic north; and direction of the enemy. All distances on the mine-section record are shown in feet. Unless extreme care is taken in the measurements, inaccuracies will limit the value of this form.

g. Use of reference points.

(1) Topographic marker. A topographic marker is a terrain feature that is easily identified on the ground and on the maps. It is used as reference point for recording the location of mine fields. In a long mine field a topographic marker should be located approximately every 500 to 1000 yards to assist in the accurate recording and early location of portions of the field.

(2) Auxiliary marker. An auxiliary marker is an artificial marker placed on the ground. It may consist of any marker, such as pickets driven firmly into the ground and bound together at the top; a large metal can buried with only a small portion above ground, or other fixed markers that will aid in locating the field.

(3) Selection. All reference points must be carefully selected and must be on the friendly side of the mine field. If the topographic marker is more than 200 yards from the mine field, an auxiliary marker must be installed. The auxiliary marker should be at least 75 yards from the mine field. All distances and magnetic azimuths must be carefully checked and recorded.

h. Alterations to mine field. All alterations to a mine field, or clearing of a field must be reported by the unit making the change or clearing the field. As changes are made, or mines removed, a complete new report, using the same forms as the original report, and marked "Revised" must be submitted. The report will be forwarded to the next higher headquarters, for distributation of this information to all units concerned.

i. Aerially emplaced mines. When possible the use of photographs will greatly facilitate the reporting and recording of mine fields emplaced from the air, such as the M83 bomb.

Figures 47, 48, 49 of FM 5-32 May 1949 to be changed as follows:

Figure 47. Location Report of minefield.
Figure 48. Detailed Record of Mine Belts.
Figure 49. Detailed Record of Mine-Field Lanes.
Figure 50. Detailed Record of Each Mine Section.

SECRET SECURITY INFORMATION

LOCATION REPORT OF MINEFIELD

1. Unit laying: Co. A, 351st. INF. REGT.

   a. Minefield No: 1 b. Sheet 1 of 4 sheets.

2. Authority: C G 88TH INF. DIV.

3. Maps reference: METZ ESCH & VICINITY 1/50,000

4. Topographical marker

   Description: R.R. Description: R.R.

   Coordinates: 685928 Coordinates: 679926

   Distance and azimuth to danger area: (See Sketch) 160 YARDS 310° AZIMUTH Distance and azimuth to danger area: 130 YARDS 310° AZIMUTH

   Or —

5. Auxiliary marker: Description: Distance and az to danger area:

6. Approximate dimensions of field; see sketch.

7. Boundary marking of field, describe. WIRE SURROUNDING FIELD

8. Total number of mines installed: Antitank 54 Antipersonnel 10.

9. Date and time installation completed: 1830 HOURS 16 MARCH 1945.

10. Signature of officer in charge: Wm C Gilliam 1st Lt.

(Sketch to include: topographical marker; auxiliary marker when used; dimension of field; general location of boundary marking; magnetic north; and direction of the enemy).

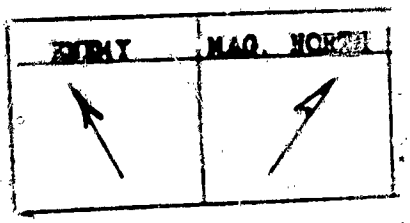
Topographical markers: - A terrain feature that is easily identified on the ground and on a map.

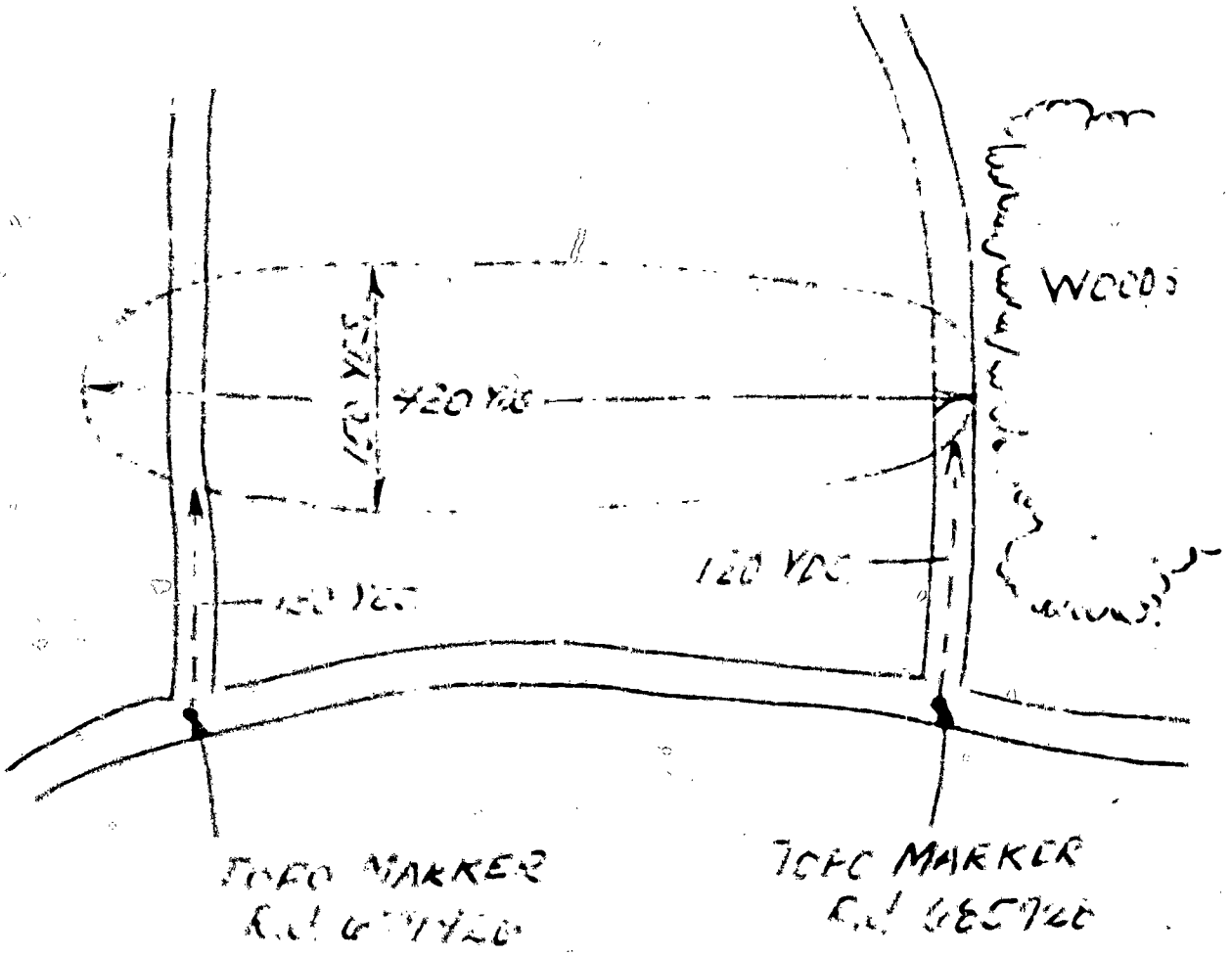
Auxiliary marker: - An artificial marker placed on the ground.

SECRET SECURITY INFORMATION

SKETCH

LOCATION REPORT





SECRET SECURITY INFORMATION

DETAILED RECORD OF MINEBELT(S)

1. Unit: CO. A. 351 STR. INF. REGT

   a. Minefield No. 1 b. Sheet 2 of 4 sheets.

2. Description of minefield to include: number of belts, pattern, use of scattered mines. 2 BELTS, STANDARD 4 ROW, SCATTERED MINES FORWARD OF BELT NUMBER 2.

3. See sketch for location of topographic and auxiliary markers.

4. Data:

Sec	As	Length Yds	Depth Yds	Antitank Mines: Total	Act	Personnel Mines: Activated Type	Act	Total in Section
1A	2	110	2	10	NONE	NONE		110
2A	28	105	25	196	2	M6 3 M2A3		111
2B	25	99	25	M6	NONE	NONE		100
2C	225	110	25	112 M6	5	M6 5		117
2D	260	100	25	196	NONE	2 M2A3		102
Belt 2:								
2A				10 M6				10
	Total Antitank			542 16	Total Antipersonnel	10 M2A3		552

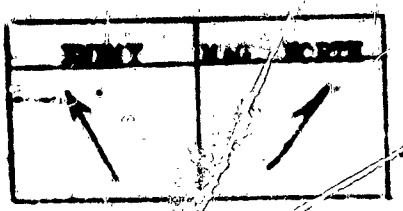
5. Signature of officer in charge: [illegible] 1st Lt.

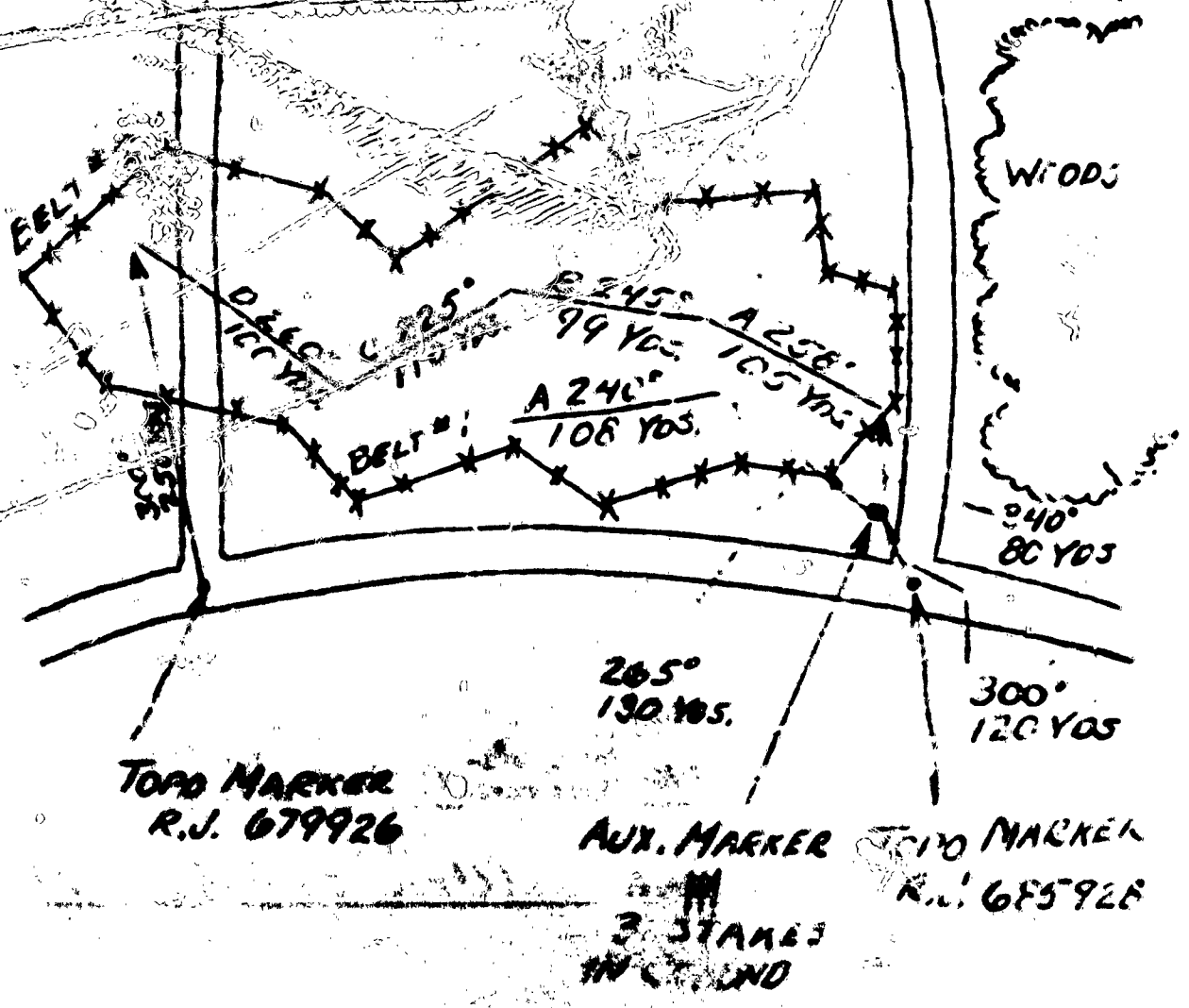
6. Date: 10 MARCH 19[illegible]

SECRET SECURITY INFORMATION

SKETCH

DETAILED MINE BELT FU[illegible]PORT





SECRET SECURITY INFORMATION

DETAILED RECORD OF MINEFIELD LANES

1. Unit: Co A 351st INF REGT

   a. Minefield No. 1 b. Sheet 3 of 4 sheets.

2. Data:

Lane No.	Topographical Marker				Lane			
	Description	Coordinates	As to Lane Entr.	Dist. to Lane Entr.	As	Length	Width	How Marked
1	RJ	665928	240°	130 YDS	340°	150 YDS	5 YDS	UNDER WIRE ON EACH SIDE. GUARD ON EACH LANE TO BE GIVEN
2	RJ	674426	350°	125 YDS.	330°	150 YDS	5 YDS	SAME

3. Provisions for closing the lanes: 5 MINES AT ENTRANCE TO EACH LANE TO BE INSTALLED BY THE GUARD.

4. (Sketch on back showing lanes:)

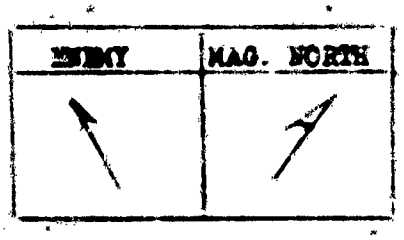
5. Signature of officer in charge: CHAS N. SMITH 1st Lt

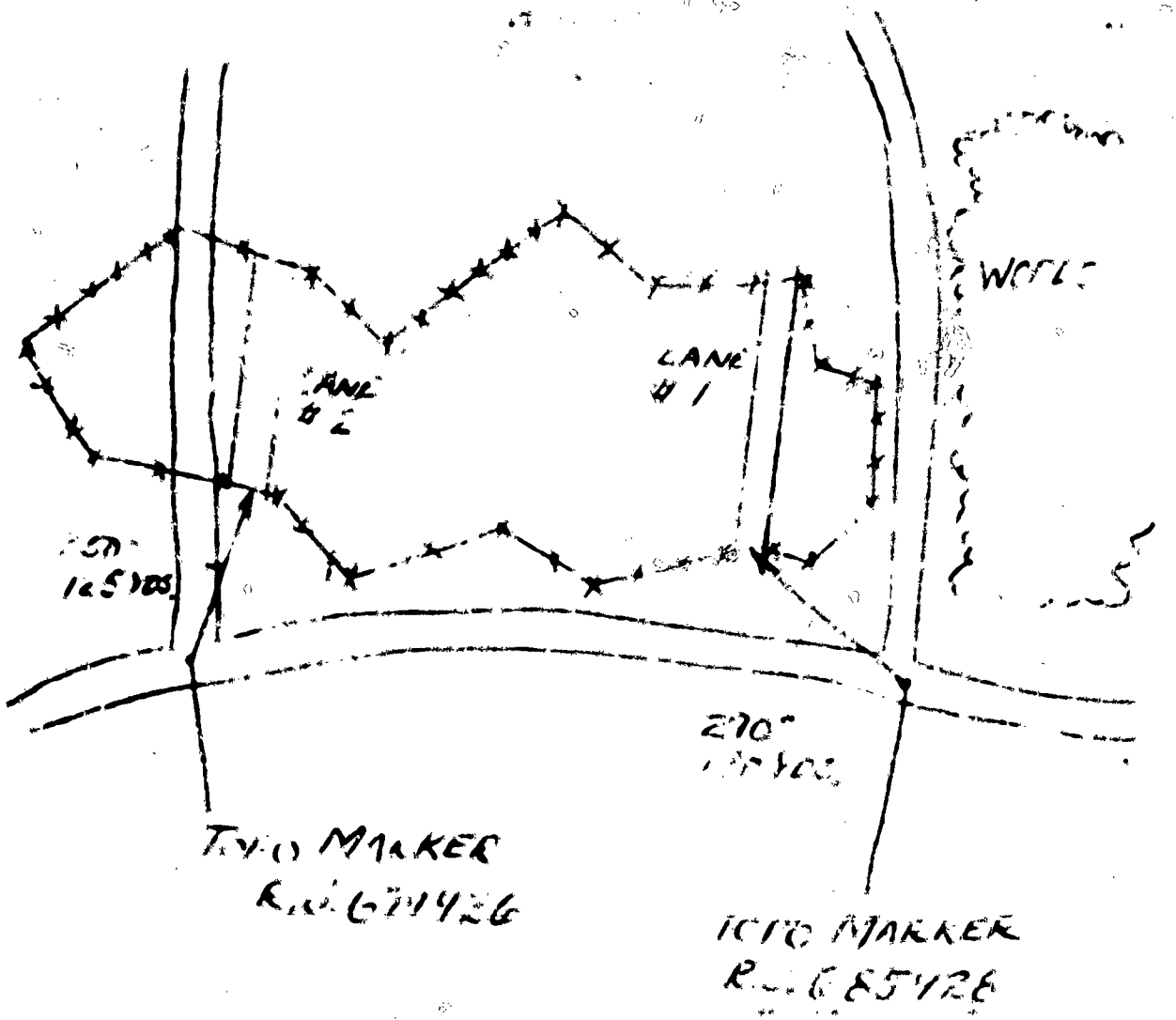
6. Date: 10 MARCH 1944

SECRET SECURITY INFORMATION

SKETCH

MINEFIELD LANES





DETAILED RECORD OF EACH MINE SECTION

ANTIPERSONNEL AND ACTIVATED ANTITANK MINES

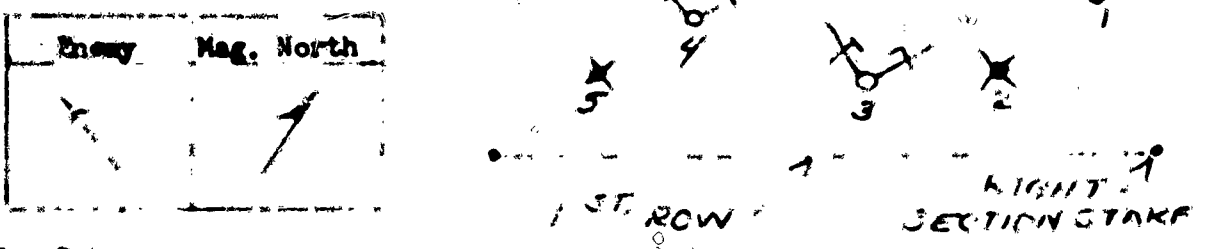
1. Unit: Co. A. 351 ST. INF. REGT.

a. Mine field No. 1. b. Sheet 4 of 4 sheets.

2. Section: 2A

3. To accompany sheet: 2

4. Sketch:



5. Data:

Mine No.	Type of Antipersonnel Mine	Type of Activated Mine	Type of Fuse	Distance From Right Section Stake	Distance Forward of Row 1
1	M2A3	NONE	COMP. M6	30 FT.	75 FT.
2	NONE	M6	PULL M1	70 FT.	50 FT.
3	M2A3	NONE	PULL M1	150 FT.	30 FT.
4	M2A3	NONE	COMP M6	190 FT.	40 FT.
5	NONE	M6	PULL M1	220 FT.	45 FT.

6. Signature of officer in charge: Clyde E. Watson 1st Lt. C.E.

7. Date: 10 MARCH 1952

APPENDIX F

RECOMMENDATIONS FOR REVISION OF FM 5-32
MAY 1959, LAND MINE WARFARE

CHAPTER 5

MINE CLEARANCE

SECTION I. GENERAL

57. GENERAL PRINCIPLES.

a. Organizational responsibilities. Tactical units breach or clear mines only to the extent necessary for their continued movement and operation. It is the responsibility of the tactical unit commander to effect this necessary clearance. Thus, a division, regiment, or task force should clear only those mines that interfere with the tactical employment of the unit. Corps units extend mine clearance to ditches, fences, hedgerows, buildings, or to 4 feet beyond the road shoulders, whichever occurs first. Corps units also clear main turn-outs, parking areas along roads, and assigned areas such as airstrips, bivouac areas, or similar installations. Army units clear all additional areas necessary for the operation of the army. Other areas may be cleared for later civilian use, and this clearance may be completely under civilian control.

b. Responsibilities of various arms. Fewer casualties will result when each arm and service is trained to conduct the mine clearing necessary for its own operations. All troops must maintain proper mine discipline in proximity to mines. Mine discipline includes training to observe mine warnings, to avoid doubtful areas, and training in manual clearing methods. Familiarization with enemy mines and mine tactics is also necessary.

(1) Infantry. Infantry must support and protect engineers in major mine field breaching operations. When necessary, engineers may be called upon to furnish mine reconnaissance parties for the advance elements of the infantry, but infantry must be able to advance through mined areas without the aid of engineers.

(2) Armored units. Antitank mines are a major hazard and render tank support extremely difficult in some operations. To reduce the number of armored vehicle casualties, constant and thorough reconnaissance must be made on all routes of approach, particularly in areas suspected or known to be mined. Units supported by tanks should aid and guide tanks through known mined areas.

(3) Field artillery. Special mine clearance detachments move forward with the reconnaissance parties to clear mines in advance of the arrival of the remainder of the artillery unit. Routes to and from the artillery will be cleared thoroughly and other areas will be cleared as necessary. Cleared areas will be carefully marked to indicate cleared areas.

(4) Navy responsibilities. The Navy will be called upon to clear mines from the deep water approaches to landing beaches. Underwater demolition teams may be called upon to clear shallow water mines. Landing force engineers must be prepared to assist in mine clearing operations for clearance of beach mine fields will be [illegible] in the vicinity of landing craft to insure [illegible] beaches. Lanes must be marked and signs posted rapidly.

(5) Service units. Those units must be responsible for mine clearance operations in their own bivouac and work areas. All personnel must be familiar with enemy mine tactics to be able to avoid suspected and marked areas.

c. Types of clearing operations.

(1) Assault gapping. Assault gapping is the breaching of one or more lanes through a mine field. Methods employed are influenced by the types of mines encountered in the mine field and by the tactical necessity.

(a) Siting and composition of mine fields and the extent of information gained by reconnaissance will influence the choice of breaching method to be employed.

(b) Numbers and types of activated antipersonnel and antitank mines and the depth of field also must be considered in breaching plans.

(c) The availability of mechanical or explosive breaching devices may dictate the breaching method to be employed.

(d) Mine fields defended by [illegible] and artillery fire require neutralization of such fire before breaching operations.

(2) Secret breaching. Since the enemy usually observe their mine fields closely, it is difficult to breach them secretly. Full use must be made of smoke, darkness, and fire support to avoid detection by the enemy. Every effort must be made to prevent the enemy from gaining knowledge of the impending assault. Disclosure of breaching plans may permit the enemy to reinforce his defense, including reinforcement of his mine fields. Secret breaching or assault [illegible] be accomplished

by probing, with or without the assistance of electrical mine detectors. Probing is generally considered to be the most accurate but most time-consuming of several means employed to detect and clear mines secretly. Forces assigned the clearance of mines, usually during the hours of darkness preceding an attack. A bridgehead may be formed to protect the cleared lanes. Engineer work on bridgeheads are widened as quickly as possible to allow combat troops through in order to maintain the momentum of the assault. Electrical detection in conjunction with probing can be used to increase speed. When detectors are used, the exact location of the mines is marked for later probing. Probing with or without the use of electrical detectors is not foolproof and care must be taken not to overlook deeply buried mines or nonmetallic or probeproof antipersonnel mines which are of small diameter and difficult to detect even by careful probing. When probeproof mines are encountered, mine clearing methods should be employed only as a last resort. If no other clearing methods are available, areas containing this type of mine must be cleared by probing every 1 to 2 inches of ground area. Probes will not normally reach deeply buried mines, but it is possible that loosened or disturbed earth may be detected above such enemy mines. Electrical detectors transmit signals which might actuate induction type fuses.

(3) Support of breaching operations. Full fire and air support, including use of smoke, may be necessary for breaching operations. When reconnaissance shows that enemy mine fields are well-protected with anti-personnel mines and will be difficult to breach secretly, other methods must be used. Explosive or mechanical methods are rapid and are used when other methods are impracticable or when time is an essential element. Every effort is made to preserve secrecy until just before the attack is launched. Coordinated air attacks may be employed and light aircraft may be used to direct fire on hostile positions. Explosive methods may be followed up with roller eradicators to eliminate mines that are not cleared by explosives because of the "skip" effect of most explosive clearing devices or other causes.

(4) Route clearing. Route clearing is a continuing operation and all roads must be continually checked against roadmining by guerilla forces or patrols. Road clearing detachments move with forward combat troops and other clearing parties periodically recheck previously cleared routes.

(a) Initial clearing includes:

1. Clearing sufficient mines, abandoned vehicles, and other road blocks to allow one-way traffic.

2. Widespread and energetic reconnaissance for bypasses or alternate routes around obstacles to avoid delay of combat elements.

3. Clearing crossroads, road junctions, road curves, bridges, booby traps and mines as early as possible.

4. Marking roads and areas with standard mine-warning signs to warn following units. This precaution is of primary importance.

(b) Second stage of progressive mine clearing is normally done by engineer troops and includes:

1. Widening the lanes for two-way traffic, including clearing shoulders, filling in craters, erecting additional warning signs, and improving bypasses.

2. Testing and improving the marking of mine fields which have not been cleared along roads.

3. Clearing and marking safe turn-offs from roads to vehicle dispersal areas.

4. Special clearing of telephone, telegraph, and railway lines upon request by the responsible service.

(5) Area clearance. Area clearance is the clearance that is accomplished after the tactical units have moved forward. The clearing troops are not normally under fire in this clearing operation and speed is not of primary importance. This operation is carried out in daylight hours and safety of personnel is a prime factor. Everything possible is done to completely clear all mines and any method may be used without regard for secrecy. If artillery fire has fallen in the mine field area, nearby mines may be sensitive and should be blown in place. Activated mines may be pulled out with ropes or blown in place. Area clearance is normally of two types:

(a) Port operation. Mine clearance in this phase is the removal of mines necessary for the use of areas of service elements following the combat units. Clearance of the following areas is generally desirable:

1. Enemy mine fields for which no records are available other than informational reports from combat troops that have previously passed through.

2. Clearance of mine fields previously laid by friendly troops and which may or may not have been recorded.

3. Clearance of friendly mine fields which temporarily may have been under enemy control or subjected to artillery fire.

(b) Post-war clearance. This is the continuation of post-operation clearance as noted above, and includes the clearance of all mines necessary for normal civilian activities. This may be accomplished entirely under civilian control.

58. RECONNAISSANCE

Reconnaissance will start immediately after detection of a hostile mine field and will be as thorough as the situation will permit.

a. Reconnaissance information required. This information includes the following:

(1) Depth and length of field is important in the preparation of plans and in deciding what breaching method or methods are to be used.

(2) Probable positions, and location and types of enemy weapons must be determined to permit preparation of support plans for the breaching operation.

(3) The location of possible bypasses is extremely important to avoid costly and time-consuming breaching operations.

(4) Information concerning metallic, nonmetallic, antipersonnel, antitank or activated mines about to be encountered is valuable to a commander who must decide the best method to breach a mined area.

(5) Patterns and densities of enemy mine fields, determined by reconnaissance patrols, may indicate the location of antitank, antipersonnel and activated mines, and thus show the pattern used. This may also dictate the breaching method to be used, and may simplify and speed the breaching operation.

(6) Information concerning obstacles, such as tank ditches, barbed-wire entanglements, terrain features, and road craters is important.

b. Methods of obtaining information.

(1) Visual aerial observation and the study of aerial photographs of suspected areas may give indication of depth and extent of mine fields. Aerial observation may disclose routes most advantageous to the attacking force, locate hostile positions and weapons, and give information about other obstacles and enemy activity.

(2) Trained aerial observers may be able to detect mines by visual observation.

(3) Study of captured enemy maps and interrogation of prisoners and local inhabitants may provide valuable information.

(4) Combat patrols may give information about barriers and enemy troops which will be valuable in planning the assault gapping.

(5) Mine field reconnaissance patrols probably provide the most reliable information. Probing can be carried out with great secrecy and is usually considered more accurate than electrical detector methods in soils of high magnetic susceptibility. The electrical detector method is considered reasonably accurate in locating metallic and nonmetallic mines. The operator must be well trained to gain speed in evaluating the signals given off by the detector. Probing must be used with the electrical detector method of pinpoint mine locations.

(6) A suggested organization for a mine-field reconnaissance patrol is one officer or noncommissioned officer and six enlisted men, three of whom are armed with carbines or submachine guns. The remainder of the party are armed only with hand grenades. All personnel are equipped as lightly as possible. The party is organized to reconnoiter a 3- to 6-foot path through a mine field, starting at a predetermined point and ending when the enemy side of the field is reached or when enemy action stops further penetration. The patrol examines all mines and booby traps in its path and if possible brings back at least one mine of each type encountered, if knowledge of their characteristics permits safe removal. A centerline tape with knots indicating location and types of various mines found constitutes the record of the patrol. Each knot represents a certain type of mine or fuze as follows:

Antipersonnel mine - one knot
Antitank mine - two knots
Trip wire - three knots
New type of mine - four knots

Ordinary shipping tags may be used instead of knots to indicate mines or trip wires located. Information is written on the tag which is then fastened to the centerline tape. An improvised code may be used to mark tags in order to save time and make marking easier at night. The knotted tape or marked tags brought in by reconnaissance patrols give valuable information concerning the enemy mine field. When laid out on the ground in a rear area they provide a means of reconstructing relative locations of mines by type and trip wires. When several of these tapes are incorporated on a sketch of a mine field area, they may give an indication of the mine-field pattern. The greater the number of reconnaissance tapes

completed, the more accurately the mine field can be plotted and the more effectively the breaching plans can be prepared.

69. EFFECTS OF COMPOSITION OF MINE FIELDS ON BREACHING

When information is available as to types of mines in a mine field, breaching operations may be greatly expedited.

a. Proteproof antipersonnel mines. When this type of mine is detected it is impracticable to probe because of the hazards and time involved. If no other detection means are available and operations must be carried out in secrecy, the probing method is used with extreme care. If secrecy is not essential, explosive or mechanical method may be used. If only antipersonnel mines are present in the mine field, tanks, rollers, or flails can breach paths ahead of the infantry.

b. Nonmetallic mines. These mines can be detected by electrical detectors if small mines are not buried too deeply. Operators can improve their ability through training, to discriminate between false and true signals. Many signals must be further investigated by probing to determine whether they are actually true or false. When small nonmetallic antipersonnel mines, which cannot be detected by electrical detectors, are planted to protect antitank mines, commanders must resort to other methods of breaching. Explosive methods may be used and followed up with flails or roller eradicators.

c. Breachproof mines. These mines are usually of heavy metallic construction and can be detected by electrical detectors or by probing. These mines may also be cleared by an displacement device such as mine clearing plows.

d. Antitank and antipersonnel mines, separate, mixed, or in adjacent belts.

(1) Antitank mines. Antitank mines alone can be detected by probing or by electrical detectors and can be hand-lifted or removed by rope, if activated. After the mine is removed, the hole must be checked with a detector or probe to ascertain that not more than one mine was laid in the hole. Mines buried more than 18 inches are extremely difficult to detect or remove. Influence fuses may require accurate reproduction of the actuating influences for clearance.

(2) Antipersonnel mines. These mines can usually be detected by electrical detectors or probing. When mines cannot be detected they may

be eradicated by explosive or mechanical devices. The "butterfly" bomb, M 83, is emplaced by air, normally behind enemy lines. Because of its sensitive antidisturbance fuze, when this type mine is encountered by friendly forces, no disarming attempt should be made. This mine can be exploded by rifle or automatic weapons fire or by passage of an armored vehicle within several feet of the mine.

(3) Mixed antitank and antipersonnel mines. If mechanical devices, effective against both antitank and antipersonnel mines are not available, antipersonnel mines may first be eliminated by explosive methods and then unexploded antitank mines are removed manually. Entire manual clearing may be necessary.

(4) Selection of breaching method. The breaching method is selected after consideration of the following factors, listed in order of importance:

(a) The mission of the command and particularly with respect to requirements for time and extent of clearance required.

(b) The availability of troops and breaching equipment.

(c) The hostile defense of the mine field and friendly offensive capabilities.

(d) The types of mines present in the field to be breached, or the composition of the field.

SECTION II. BREACHING OPERATIONS

60. DETAILS OF METHODS.

a. Manual. Because present standard detectors are not entirely satisfactory under all conditions, detectors must be supplemented with probing and visual detection in areas suspected of containing nonmetallic and small antipersonnel mines.

(1) Probing. Mines usually can be located readily by mine probes, bayonets, or stiff wires. When bayonets are used, extreme care must be exercised to avoid detonating Schu-mine type antipersonnel mines. In the absence of reliable nonmetallic mine detectors, probing is generally the best way to locate nonmetallic antitank and antipersonnel mines. Most mines can be located by the prober as he crawls forward on his hands and knees, feeling and probing. The hands and arms (sleeves rolled up) are used to find trip wires and pressure type antipersonnel mines. In probing, the

probe is pushed into the ground at an angle less than 45 degrees to avoid setting off sensitive antipersonnel mines. In searching an area, one man should cover about 1 yard of front, probing every 1½ to 6 inches (depending on the type mines encountered) and before he moves forward, feeling with hands and arms for trip wires, pressure fuses, and mines laying on top of ground. The mine probe, M1, is normally used without the extension when probing from the kneeling position. The extension is used in pot holes, road shoulders, footpaths and in brush. The short probe should be used whenever possible, keeping the body near the earth and as far away as possible from the mines being probed. To avoid detonating the mines, the probe should be pushed, but not jabbed, into the ground.

(2) Detectors. The use of electric mine detectors is the most rapid way available to locate individual metallic mines. Mine detectors can locate either metallic or nonmetallic mines but all detectors have their limitations with respect to false signals, depth of detection, and operation over certain types of soil. The AN/PRS-3 reliably detects metallic mines, and nonmetallic mines having metallic content. This detector locates other small metallic fragments. It is immersionproof and can be operated in water. The AN/PRS-4 is an ultra high-frequency detector and is capable of detecting metallic or nonmetallic antitank mines in 7 inches of soil, except dry sand and gravel, and antipersonnel mines in 2 inches of soil when the mines are as large as 4 inches in diameter. This detector is subject to false signals from air pockets, rocks, roots and when the search head is tilted from the horizontal plane. The detector should be operated with the searchhead 0 to 3 inches above the ground. Effective use is extremely dependent upon the state of training of the operators. Untrained operators are of little value because proper interpretation of signals given by the detector is vital to its successful use.

(3) Protective devices. There is a need for protective devices that can be worn or used by individuals disarming or locating mines in a mined area. Protective flyer's armor affords protection against fragments from antipersonnel, antitank mines, hand grenades, and pistol fire, but not against rifle fire at close range. This suit partially covers the chest, back, crotch, and groin of the wearer. Overshoes or boots worn over the shoes may give some protection against antipersonnel mines for feet and legs. Unbreakable goggles and face pieces may provide some protection against explosive blast, dirt, and fragments. The US Marine Corps has a shoe pack that is reported to have been used successfully in Korea against antipersonnel mines. It is understood that trapped air between double soles of the shoe and felt inner soles provides a cushioning effect against mine blast.

(4) Manual clearance and removal of mines. Mine clearance is the locating and removal or destruction of mines. The method of

mine disposal is a command decision. Mines may be removed from the ground manually, either by hand or pulled out by wire or rope, or destroyed in place by explosives.

(a) Hand removal. Hand removal is employed when mines must be removed silently or when undesirable destruction of nearby structures would result from detonation of the mine in place. The following sequence should be followed:

1. Probe to locate exact location of mine.
2. Uncover dirt from mine to identify type; remove earth from around mine and feel for wires and activation devices.
3. When all devices on top and sides of mines are neutralized, dig a hole to one side of mine. Then dig under mine and feel with fingers for any additional devices; neutralize any found. A small mirror often helps in this operation.
4. Carefully lift mine and move to a safe place for disposal.

(b) Rope removal. Rope removal is safer and quicker than hand removal and in some instances is the proper method of disposal. When actuated mines are pulled and exploded, nearby mines may become sensitive as a result of the blast. Procedure for pulling mines by wire or rope is as follows:

1. Probe to locate mine.
2. Uncover top of mine.
3. Attach 50-yard rope or wire to mine or group of mines without moving or disturbing them.
4. Move all personnel from field to a known clear area. This prevents casualties should sympathetic detonation occur. Areas of protective cover from which ropes are to be pulled must be searched for anti-personnel mines.

5. Take cover and pull mines from holes.

6. If mines do not detonate, wait 30 seconds before moving up to mines. This prevents casualties from delay action fuzes.

7. Check for additional mines, pull wires, and activation devices.

8. Carry mines to dumps for later disposal or re-use.

b. Mechanical clearing. Many types of rollers, plows, dozers, flails, and jet devices have been tested against pressure type antipersonnel and antitank mines but the weight and size of these devices are definite limitations.

(1) Rollers. Currently, the most effective method of eradicating mines by mechanical devices is the use of rollers which consist of parallel disks approximately 4 feet in diameter, individually suspended, and enclosed in a frame which is attached to the front end of a tank. This roller can be used alone to breach a path or it can be used in conjunction with explosive clearing devices. It is effective against most contact type mine fuzes, and may be used in assault gapping because of its speed.

(2) Flails. This method employs heavy chain flails which remove 3 to 6 inches of soil and explode the mines in place. The characteristics of this device limit its employment to roads and gently sloping terrain.

(3) Plows. The mine plow evacuator is a positive action clearing device for clearing all types of mines. Its forward action causes a cushion of earth to push up between the plow and the mine. It is slow moving and needs an enormous amount of pushing power. The plow is apparently capable of deeper eradication than any other device.

(4) Improvised methods. These are devices or methods to supplement standard approved methods or to be used when other methods are not available. The use of tractors, trucks, tracked vehicles, or any vehicle that can be pushed through a mine field ahead of another vehicle of approximately the same track width may be valuable. If the vehicle can move under its own power, it may be started in a low gear range in the direction of the lane to be breached. Additional vehicles may similarly be used until the far side is reached. If the vehicle has sufficient power, other equipment may be towed slightly offset to either side to get better

coverage of the lane. If one of our own tanks has struck a mine, another vehicle could continue pushing the damaged vehicle through the mine field until the enemy side is reached. The use of detonating cord made up into bundles of 10 to 14 strands, 25- to 100-feet long, is one method of improvised clearance. The rope is thrown or projected by rifle grenades or inert mortar rounds and detonated by electric or nonelectric blasting caps, thus breaching a path for attacking infantry. A grapnel hook attached to a rope or wire can be thrown across antipersonnel mine fields and drawn back by pulling the rope. The grapnel may catch trip wires and explode mines in its path.

c. Explosive method. Explosive methods are used most advantageously when surprise and speed in the attack is essential, and when fields are so cluttered with activated or probeproof mines that it would be impractical to use other existing methods. Preparation of equipment and placing it into position is time consuming, and foresight is essential to gain speed and to avoid undue delay. Terrain features may dictate the type and length of explosive used. These methods may employ linear explosives of various types and bangalore torpedoes.

d. Floating and Amphibious mines.

(1) Breaching floating or antiamphibious type mines may be accomplished much the same way as with conventional type mines. Floating mines may possibly be exploded by rifle or automatic weapons fire or by placing a charge near the floating mine. Booms may be constructed to protect floating bridges or piers of stationary bridges. These are constructed of chain or wire rope and logs which extend from bank to bank and secured to large trees or other anchorage. If part of the boom is destroyed, it must be replaced immediately with material previously stockpiled on the bank. If mines become beached, they can be detonated by explosive charges or weapons fire.

(2) Breaching of mines placed between low and high tide levels to oppose amphibious landings may be accomplished by normal methods during low tide. Amphibious crushers, depth charges, and charges placed by underwater demolition teams, may be used to detonate underwater mines. Immersionproof detectors assist in locating these mines. There is a possibility that hydraulic jets can be used to displace underwater mines.